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MY BODY AND HOW IT WORKS

By

DOROTHY WALTER BARUCH
And OSCAR REISS, M.D.

With a Foreword by
LOGAN CLENDENING, M.D.

Author of "THE HUMAN BODY"



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MY BODY AND HOW IT WORKS

5



"Just see his muscles, will you? What muscles!"

MY BODY AND HOW IT WORKS

A First Physiology

By

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MY BODY AND HOW IT WORKS

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This little book carries the endorsement of prominent child health specialists and educators all over the country. Among these are the following physicians, all of whom are Professors of Pediatrics in leading universities: Dr. Frank Gengenbach, University of Colorado, Denver; Dr. J. Victor Greenebaum, University of Cincinnati, Cincinnati; Dr. Clifford G. Grulée, Professor of Pediatrics at Rush Medical College, Chicago, and Secretary of the American Academy of Pediatrics; Dr. Julius Hess, University of Illinois, Urbana; Dr. William Palmer Lucas, University of California, Berkeley; Dr. Frank C. Neff, University of Kansas, Kansas City; Dr. Langley Porter, Dean, University of California Medical School; Dr. Edward B. Shaw, University of California; Dr. Ralph M. Tyson, Temple University Medical School, Philadelphia.

Many leading educators, pediatricians and psychiatrists have also endorsed the book. Among them are: Dr. Isaac Abt, of Chicago; Dr. C.

Anderson Aldrich of Winnetka; Dr. Forrest Anderson of Los Angeles, Director of the Los Angeles Child Guidance Clinic; Dr. John E. Anderson, Institute of Child Welfare, University of Minnesota, Minneapolis; Dr. Tobias Birnberg of St. Paul; Dr. Edgar P. Copeland of Washington; Dr. Jay I. Durand of Seattle; Dr. G. V. Hamilton of Newton, Ohio, author of "A Research in Marriage" and "What Is Wrong With Marriage"; Dr. Mark Jampolis of Chicago; Dr. Nadina R. Kavinoky of Los Angeles; Dr. A. Levinson of Chicago; Dr. A. J. Rosanoff of Los Angeles; Dr. Edward H. Schoolman, lecturer of Chicago; Dr. Louis Segar of Indianapolis; Dr. Nila B. Smith, Dean, Broadoaks School of Education, Whittier College, Pasadena; Dr. George D. Stoddard, Iowa University, Director of Child Welfare Research Station; Dr. William Weston of Columbia, South Carolina; Dr. Donald K. Woods of San Diego.

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Foreword

I have read the book called *MY BODY AND HOW IT WORKS: A First Physiology* by Dorothy Baruch and Oscar Reiss with great interest. It is dependable and exceptionally interesting besides.

In my opinion, also, it has caught the right attitude of a child's mind and should be of great value to mothers and fathers and teachers who wish to know how to answer intelligently and seriously the questions which young people ask them about their bodies.

LOGAN CLENDENING

Preface

This book by Dr. Reiss and Mrs. Baruch is directed to our children, but the preface is addressed to fellow parents, teachers, school boards, superintendents of education, and faculties of schools for the training of teachers.

The teaching of health in our elementary schools and high schools is still an unsolved problem. But parents and teachers, as well as physicians, are gradually recognizing that it is a problem of the first order. This is a cheerful sign. The teaching of health in our public schools has to date largely been an endeavor to establish correct health habits in our children, without furnishing the necessary facts that would permit the child to understand or rationalize such habits. In other words, the teaching of health has been on the same basis as the teaching of social mores—do this and don't do that. That such teaching of health is largely futile appears to be shown by the appalling ignorance in essentials of health in a population capable in the three R's. The method of teaching health by example and dictation is, of

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course, necessary in the home in the earliest years of child life. But we now have a body of proven information in physiology, anatomy, nutrition, bacteriology, immunity, causation of disease, etc., that puts health principles and the teaching of these principles on an entirely different basis from that of the changing social mores. The problem before our schools is how to bring in such instruction in the most effective way and how to fit it into our present school curriculum. The welfare of society seems to demand an objective teaching of health in our public schools as well organized and as continuous throughout the school years as the teaching of the three R's; this cannot be left to the teachers of other subjects, or even to the teachers of physical education, as trained at present. Even with able teachers well trained in physiology and hygiene, it cannot be accomplished in the few high-school weeks, required by law in some states, for the teaching of personal or public hygiene, the action of alcohol and narcotics on the human body, precautions against infections, and the tooth-brush drill.

The fact that even in our best high schools we

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have teachers specially trained for and, in many cases, giving their whole time to such subjects as Latin, German, French, or higher mathematics, but almost never a teacher specially trained in and giving his or her whole time to the teaching of health, which, from the point of view of the future citizen and society as a whole, seems more important than any of the others, should make us pause and ponder.

The present volume is a noteworthy attempt to put the elementary facts of anatomy, physiology, and health in a language intelligible to the youngest child in the grades. It is a credit to the authors in the matter of clarity, and in freedom from fads and propaganda, blemishes that obscure so much of present-day health-teaching in our schools. But the printed word itself, however skillfully presented, is insufficient. The book must be supplemented by illustrative material, examples, etc., at all stages of the teaching. The teacher must know a great deal more about the human body in health and disease than it is possible to impart effectively to the child.

That the senior author of this A B C of health

PREFACE

is a physician is a sign of the growing recognition of the medical profession of its responsibilities towards the healthy man, woman, and child. The teaching of health in our schools must be done by the school-teacher, preferably the teacher of biology. But in the selection of content and illustrative material, and in elimination of fads and follies, the doctor can be and will be of invaluable aid to the educator. For the well-trained physician knows more about the human body in health and disease than do members of any other group in society.

A. J. CARLSON

University of Chicago

March 1, 1933.

MY BODY AND HOW IT WORKS

“I want to know how clocks work,” said Jean.

“I want to know how airplanes work,” said John.

“I want to know how *I* work,” said Jerry.

And so this book was written.

It does not tell how clocks are made, nor about the parts that help *them* go.

It does not tell how airplanes are made, nor about the parts that help *them* go.

But—

It does tell how people are made, and about the parts that help them jump and run and swing on swings, and hammer with hammers, and paint with brushes, and do this and that and everything that you and other people like to do.

I. Going from Outside In

Have you ever had one of those wooden dolls with smaller and smaller wooden dolls nested inside it? You know the kind where you open up the first doll and find a smaller one fitted in, and you open up that one and find a smaller one again, and inside of that a still smaller one, and so on? Perhaps the outside one has a red painted dress, and the next one a blue dress and the next one green.

If you could open yourself up in the same way you would not find red and blue and green layers, but you would find many different layers of quite other varieties as you went from the outside in.

“I can see my outside layer,” said Jerry, “when I stand in front of a mirror without any clothes on.”

So can you, by standing in front of a mirror, see your outside layer. It is made of skin and hair and nails.

Suppose you were to peel off this skin layer. You would find an uneven layer of fat underneath, more in some places than in others. . . .

MY BODY AND HOW IT WORKS

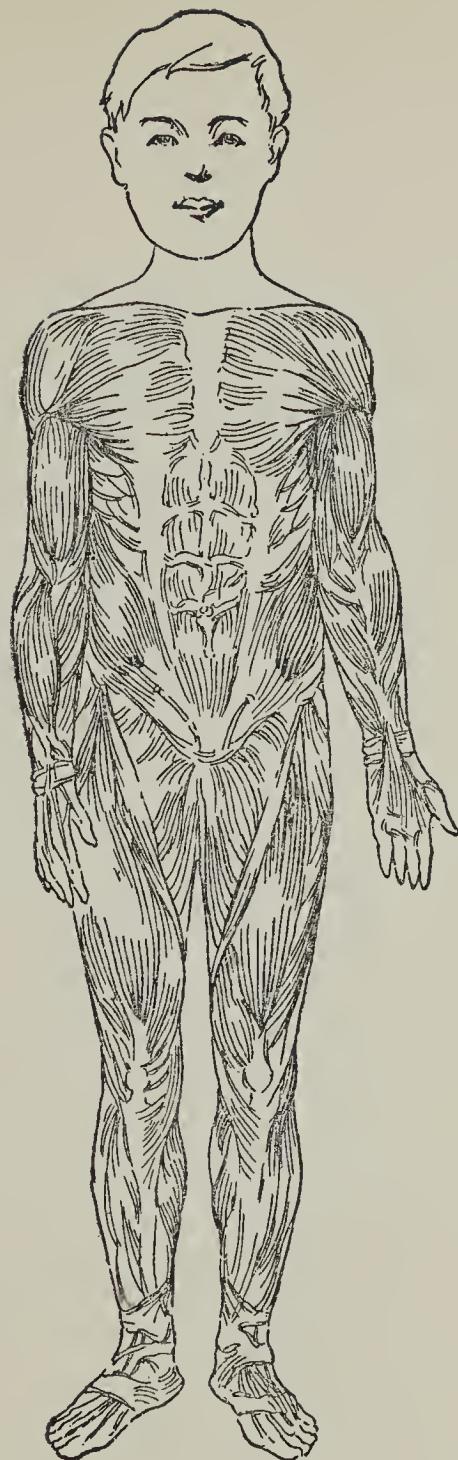
You know how fat looks, you've often seen it on meat.

And then, were you to go farther in by peeling the layers of fat off, you would next find a layer of muscles.

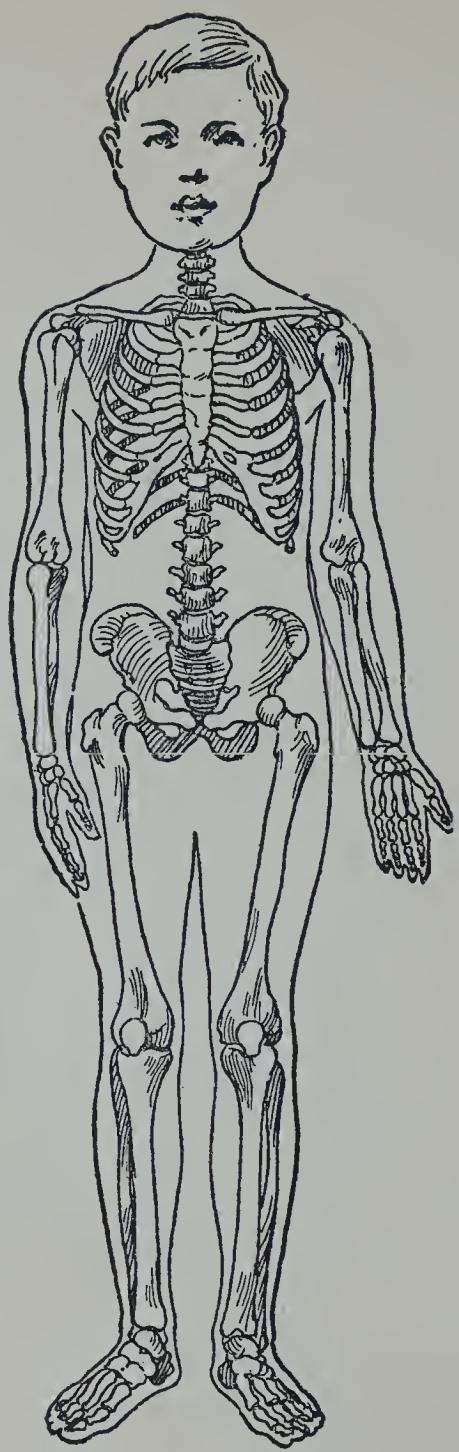
You would see the bunchy strands of muscles that stretch up and down and every which way all over you, each separate muscle wrapped in its own thin covering or sheath.

And then, if you were to peel the muscle layer off all around, you would find bones here and there in special places—hard white bones like your teeth.

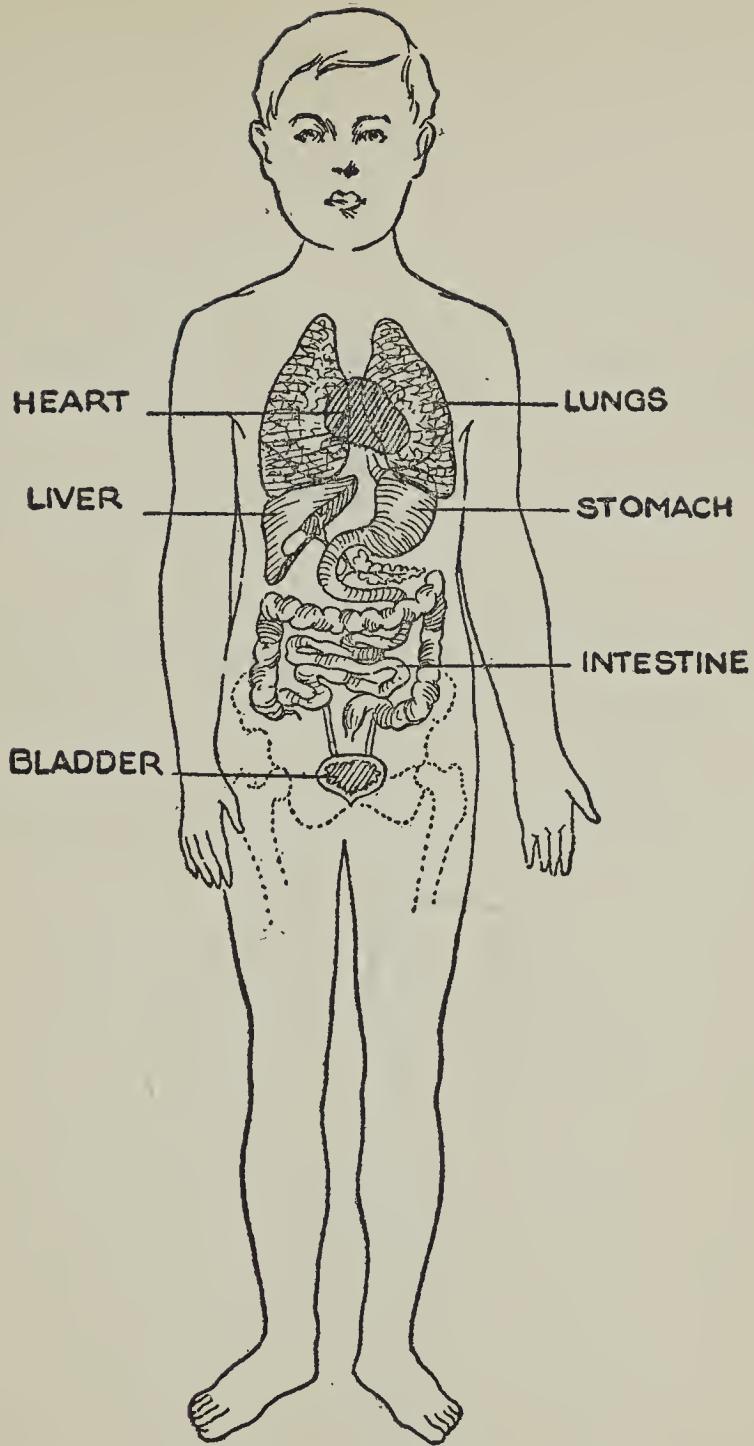
And then, having peeled off all these layers, you would find a great many different-looking organs lying under your chest and inside your abdomen. In your chest you would find principally the heart that you can feel beating there, and the lungs that help you to breathe. While in your abdomen you would find, for instance, the parts of you that help take care of the food you eat, like your stomach and liver and intestines. And you would find inside of you other parts that help you work.



If you peeled off the skin and layers of fat . . .



If you next peeled the muscle layer off . . .



If you finally peeled off fat *and* muscle layer . . .

MY BODY AND HOW IT WORKS

Naturally, you really cannot take yourself to pieces this way. If you were even to begin pulling off the outside layer of skin, one of the inside parts of you—your nerves—would make you cry, “Ouch! Ouch!” and you would stop right off.

But, anyway, there you are, with many, many parts to you—more parts than a clock has, more parts than an engine has, more parts than even an airplane.

Each one of these parts, in turn, is made up of many tiny parts. Each tiny part is called a *cell*. These cells are so tiny that you would need the strong magnifying glass of a microscope in order to see them.

Were you to look at a bit of *skin* from the top of your hand under the microscope, you would see some cells that look like this:



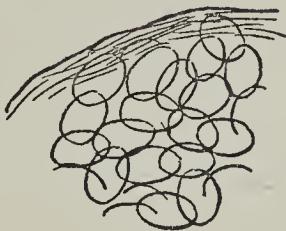
Were you then to look at a piece of *muscle*

GOING FROM OUTSIDE IN

from your arm you would see cells that look like this:



Were you to look at a bit of *fat*, you would see again different-looking cells—some like this:



But then it is not surprising that skin, for instance, is made of different cells from fat. Skin and fat do not look a bit alike, so why should they be made of the same sort of cells?

When a whole lot of cells are bunched together they make up the materials out of which the various parts of the body are formed. These materials are called tissues. A whole lot of muscle cells bunched together form the muscle tissue out of

MY BODY AND HOW IT WORKS

which muscles are made. A whole bunch of bone cells together form bone tissue out of which the bones are made. And so on.

John wanted to know if his black puppy dog was made up of a lot of different cells too. And Jean wanted to know if her canary bird was. Jerry laughed and said he knew, all right, that they were.

So there you are with the many, many tiny, tiny cells put together to make up many, many different parts. And the many, many different parts put together to make up the whole person.

The different parts help you when you do things. They help you when you eat. They help you when you sleep. They help you when you want to dance to lovely music or splash into the ocean's waves. They help you grow. They help you live.

II. The Parts of You That You See All the Time

When you look at a canary bird you see yellow feathers covering the outside of him; when you look at a bear you see coarse black hair; when you look at a toad you see grayish, lumpy, warty skin. When you look at yourself, you see skin, too, only, "Thank goodness," you say, "my skin is much better-looking than a toad's."

Yet even though it is prettier, your skin is just as useful to you as the toad's skin is to the toad. It very serviceably protects the inside parts of your body.

If you've ever gone to a candy store and picked out some marshmallows and lemon drops and chocolates to take home, you have watched the salesgirl put these into a bag and you've known that the bag would protect the candies and keep them clean so that dust and dirt would not get all over them.

Well, the skin keeps dust and dirt and all kinds of other things from getting at the deeper tissues

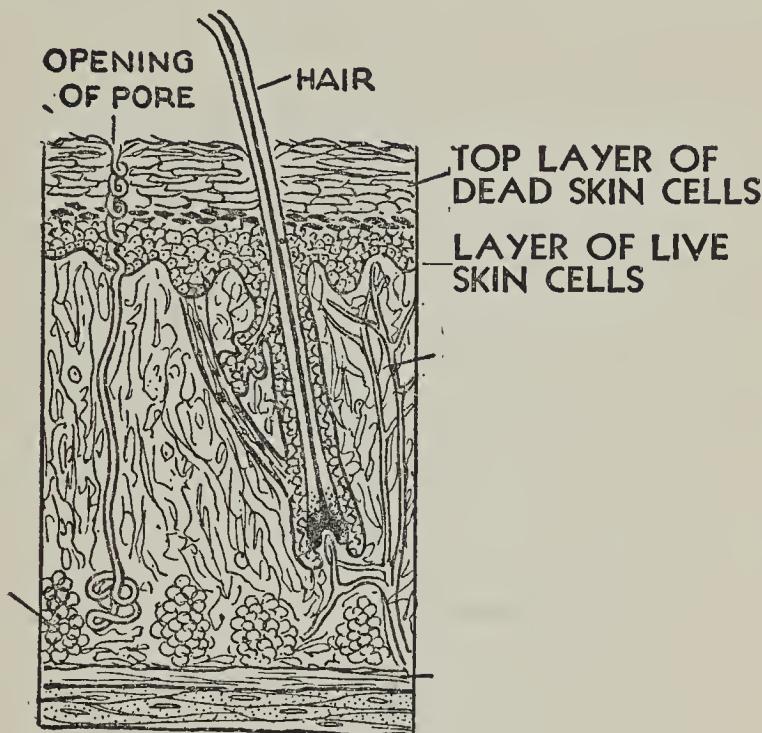
MY BODY AND HOW IT WORKS

which it covers. If you happen to scrape your knee in climbing against a rough board, you notice at once that the skin no longer covers the tissues at the cut place, and you paint on some red or brown medicine to kill any germs that might try to find a way in through the cut. But you would never ordinarily paint your legs or face or arms to keep out the germs. That would be too silly, for your skin is already there to keep the germs out. Your skin is there as protection. You could stand out in a storm and let it rain cats and dogs on your skin, and yet, fortunately, none of the water would run through to the inside of you, for if it did it would get mixed up with a lot of other fluids inside and would make quite a mess.

A thing you can't see about your skin is that it is made up of several layers, one on top of the other, somewhat like the layers of an onion. The underneath layer is supplied with blood and is made up of living cells. But the outer layer has no blood supply and is made up of dead cells. So if you scratch yourself but do not bleed, you'll know that you have scratched through and broken the outer layer of skin only.

PARTS OF YOU THAT YOU SEE ALL THE TIME

The dead skin is being constantly shed. Doubtless you've noticed skin shedding after you've been sunburnt and an extraordinary amount is peeling off, but as a rule you can't see the shed-



ding, nor can you notice any bare spots of you with no outer skin on, because the live cells underneath are constantly growing and dying and so are again and again making new dead cells on top.

Your nails are made of dead cells, too.

"But," questioned Jerry, "if nails are dead, how do they grow?"

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"And they *do* grow," put in Jean. "Mine have to be cut every week. They're a nuisance."

Whereupon John thoughtfully added, "Yes, they grow from the tip, longer and longer."

But nails don't grow from the tip. The dead horny cells are pushed out from the bottom, where the finger nail begins.

Hair, too, grows from the bottom and has dead cells on top, so that when you go to the barber he takes off the oldest part of your hair and lets the newer growing part at the roots stay on.

"I can see little spots like little holes all over my skin," said Jerry.

So can you. They are called pores. They are the little, tiny faucets of the sweat glands. They let out from inside the body some of the water which the body has not used. Perspiration, we call it.

Perhaps, if you've noticed yourself, you may think you perspire only under your arms and in the palms of your hands and on the soles of your feet and on your forehead. You perspire more in those places than in others. But you actually perspire *all* over your body *all* the time, even though you don't notice it. You perspire enough to fill from four to five ordinary glasses every single

PARTS OF YOU THAT YOU SEE ALL THE TIME

day. Doesn't that sound almost impossible? But it's true. And at times you perspire even more.

There is a story about a boy who, while riding along on his bicycle, suddenly heard a siren screech. A fire engine rushed by. He had to follow it. Around went the pedals of his bike, faster, faster. It was very hot. He became dripping wet. But the fire had been a false alarm, so on he rode to his home. When his mother saw him she put up her hands and cried, "Well, I guess you had to stand right in front of the fire hose—that soaking wet you are!"

If we exercise violently we perspire more, or if it's hot, or if we happen to hurt ourselves and are in pain, or if we happen to be afraid.

Then, too, there is another kind of liquid which the skin lets off. It is oil. There are oil glands in the skin all over, except in the palms of our hands and on the soles of our feet. For one thing, the oil keeps the skin from losing water too quickly. In the ear, curiously, these oil glands manufacture wax.

"And on my nose," said Jerry, "they make me shine." And so they do, probably often, on your nose, too.

III. What Happens When You Eat

When you sit down at the table, you take your fork and pick up a mouthful of spinach, perhaps, or a mouthful of potato or meat. And you chew and chew, and as you chew, your teeth break up the pieces of food into smaller and smaller bits. And the watery saliva inside your mouth mixes with the bits of food and makes the food wet and slippery so that it is easy to swallow.

Jerry took a dry piece of bread. He started chewing, looking thoughtful the while.

“Yes,” he said in a few seconds, “it’s gotten all wet.” And then he almost shouted a discovery, “And it’s turned sweet.”

That was because the digestive juices in the saliva had begun to digest the bread—to change it and make it turn sweetish.

When you swallow, the food goes down your throat, down a tube called the œsophagus.

At first, John thought that the tube was perhaps hard, like a metal pipe. But he soon learned

WHAT HAPPENS WHEN YOU EAT

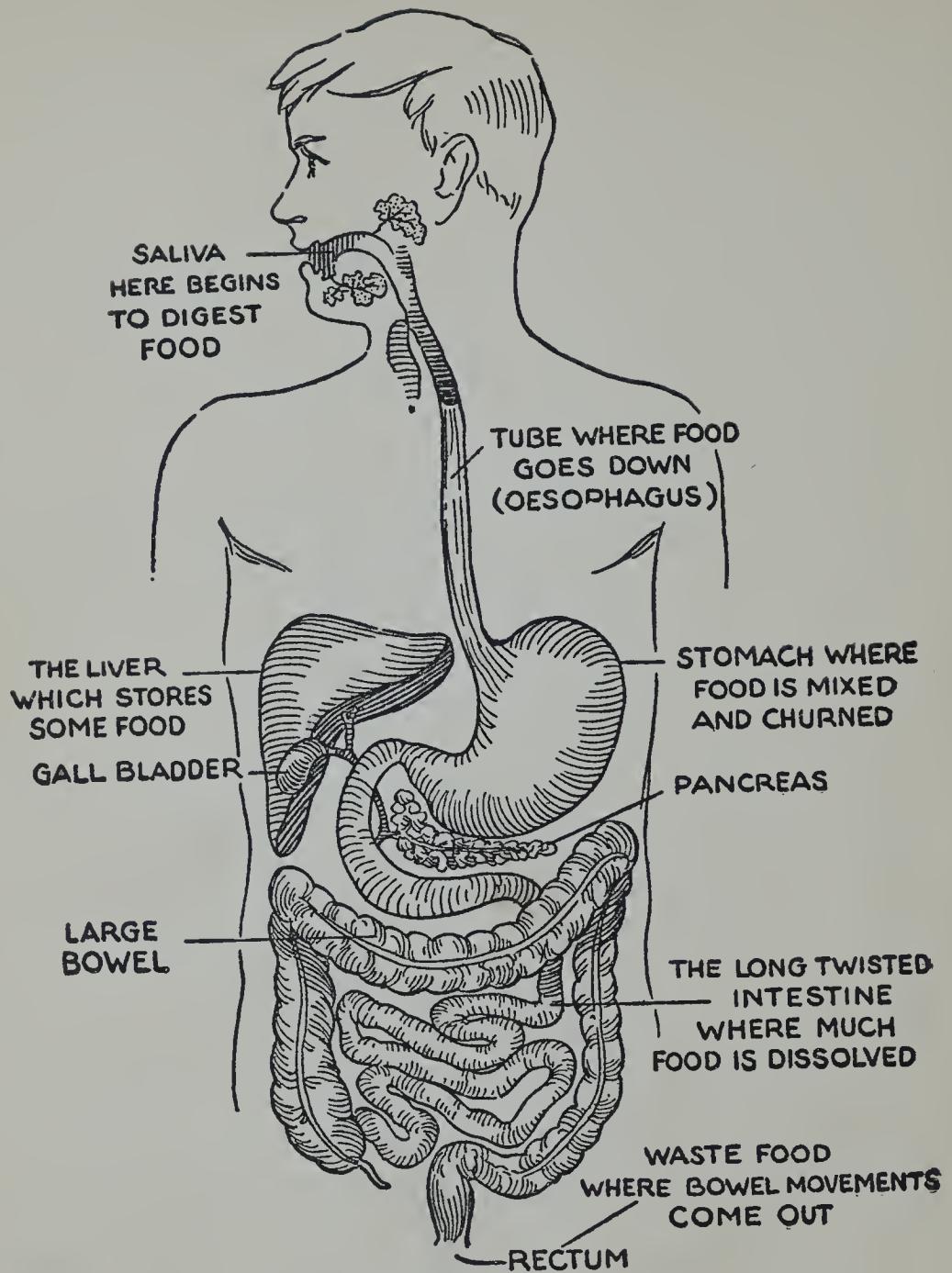
that it is more like a rubber hose, except for its inside being softer and moister, very much like the inside of your cheek which you can feel by putting your finger in your mouth.

Down this œsophagus tube your food travels until it reaches your stomach. But at that it hasn't gone very far down, not even quite so far down as your navel.

The stomach looks like a balloon made of muscles and shaped like a duck without a head.

When the food reaches the stomach, the inside of the stomach pours out digestive juices into the food, in the same way as the mouth poured saliva. And with that the stomach starts to grind and churn the food, mixing it thoroughly with the juices. Then the food goes farther. The stomach squeezes it out, a little at a time, taking from two to four hours to make the whole amount pass on.

The food then goes into a twisty, curling tube called the intestine. If you were to take the intestine out of the body and stretch it along the floor and measure it with a tape measure, you would find that it was about twenty-two feet long; that is about four times as long as your mother is tall.



Digestive System

WHAT HAPPENS WHEN YOU EAT

Naturally, there is not room for the intestine to be stretched out inside your abdomen, so instead it is coiled into loops and twists.

“And the food travels a long way all through these coils,” wisely commented Jean.

And as the food travels, digestive juices are again poured over it from the lining of the coiled intestine. Juices are added also from some big organs nearby connected with the intestine by little tubes. Some juice is added from the pancreas, a large yellowish organ, while still another juice is poured in from the liver, a great dark-red organ, through the gall bladder, which looks like a smaller, round, purplish plum.

You would suppose, naturally, that with so many juices pouring over the food in the intestine, many changes would be apt to happen to it. Quite true! For parts of the food are completely dissolved by the juices, just as a lump of sugar dropped into a cup of coffee is dissolved.

If you were to see the dissolved part of the food you would say, “Oh, it doesn’t look like food at all—it’s entirely liquid.”

The fact that it is completely liquid is very,

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very important. It means that at last the dissolved part of the food you have eaten is ready for a most astonishing thing to happen to it. It begins to pass out of the tube, not by flowing out of any particular opening, but by seeping right through the walls of the tube, much the way water oozes through a piece of cloth.

It is easy to see that big pieces or even little bits of solid food could not get through this way. Only liquid can. That is why all the digesting, all the melting and absorbing and dissolving, of solid food into liquid has had to take place.

Jerry wanted to know where this liquid food went after seeping through the walls of the intestine.

It goes into the blood.

In the blood, the food is carried all around your body. It is carried to wherever it is needed to repair the cells that have become worn out by work in the same fashion as your shoes become worn out when you've given them a lot to do. It is carried, too, wherever it is needed to help the many different parts of you carry on their many different jobs.

WHAT HAPPENS WHEN YOU EAT

Food goes to your legs and feet and helps them run; it goes to your eyes and helps them see; it goes to your nose and helps it smell. Wherever there is work to be done it serves as fuel, just as gasoline serves as fuel for an automobile and gives it power to work, or as coal serves as fuel for an engine and gives it power.

The transformed food, you see, does two big things for you: it furnishes the sort of fluid that can be used to repair cells, and it acts as fuel that can burn in the body.

"My goodness!" cried John. "Does it burn in a big fiery flame inside of us?"

No, naturally it does not burn in a big flame. Tiny little specks only burn at a time, here and there, in tiny little explosions that cannot be seen or smelled in any way, but that do give off power for working.

However, as you may imagine, your body does not use up all its food-fuel immediately, quickly, all at one time. It does not need it all at once. Therefore it must store part of it for a while. The liver acts as a storehouse and keeps a supply of fuel on hand ready for use as it is needed, much

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as a coal-car or oil-tank-car keeps its supply of fuel on hand for an engine.

Now if you stop a moment to think, you will remember how, whenever any fuel is burned, a waste part of it is left which fails to burn. When wood burns in a fireplace, for instance, you have seen the ashes left. Well, when food-fuel burns in the body there are also waste parts left. These are of no more use, and the body needs to get rid of them.

There are two chief ways of getting rid of them. You use both ways when you go to the toilet. One way is through urination, the other through bowel movements.

But this fuel waste is not the only thing that is carried off in your bowel movements. In the bowel movements there is carried off, for the most part, a lot of undigested, unused food.

To understand about this you will have to think back a step or two. You will remember that part of the food in the long, twisty, coiled intestine had been changed by digestive juices into a thin, watery liquid. You will remember, too, that thin liquid like this was the only thing that could pass

WHAT HAPPENS WHEN YOU EAT

through those walls, because whatever went through had to ooze through like water through a cloth.

Now, some of the food that had reached the intestine was not changed sufficiently into liquid to ooze through those walls. It had remained partly solid and undigested in the intestine. It was of no more use to the body. It had to be gotten rid of. And so it traveled on down the twisty coils of the intestine until it emptied into a wide tube called the large bowel. Farther on still it traveled until at last it came to an opening called the rectum, and from there, in your bowel movements, it passed out.

Sometimes, when your bowels move, you can recognize food, like kernels of corn or bits of nut. Your teeth did not grind them sufficiently in the first place, and they passed down the œsophagus through the stomach, through the intestines, into the large bowel and out without much changing. Not being sufficiently ground up, they could not be changed or digested by the juices.

It is very important to get rid of undigested food and other waste materials in order to keep

MY BODY AND HOW IT WORKS

healthy. Consequently, it is very important to see that your bowels move every day. After breakfast in the morning is a good time.

The waste that passes out of the body when you urinate has been taken by the blood to two special filtering stations called kidneys. The kidneys lie above your hip bones, near your back, one on each side of you. They draw in and filter certain waste fluids from the blood. Then these fluids run down two thin tubes called ureters to a sort of balloon-bag storage tank, called the bladder.

When the storage-tank bladder gets full, the urine inside presses against a little door, or valve, the valve opens and the urine runs out through another tube called the urethra.

In boys the urethra runs down the center of the penis and its opening is easily seen. In girls the urethra opens between the legs near the top of the fold that is called the vulva.

And so the body gets rid of the waste material that is no longer useful. The good part of the food, however, it uses, as you know, to help it work and to repair worn-out cells.

But, at that, the body can use only a certain

WHAT HAPPENS WHEN YOU EAT

amount of food for work and repair, and it can store only a limited further amount in the liver. So, after that, if more good food is continually eaten and digested, a new storage place must be found. And it *is* found—under the skin, for the extra food turns into fat and is stored in this form under the skin, and the person who eats too much grows rounder and chubbier.

Some children, however, do not have the right sort of food to eat. Poor things! They become tired quickly and are fussy, and they whine and cry a lot because they're tired. They don't grow properly, either.

They don't grow any better than do white rats who have not had the right kind of food.

Once two white baby rats were put into separate cages. One of the rats was given proper food.



The other one was not. And presently the one that was given proper food grew into a beautiful silky, snow-white beauty with bright pink eyes,

while the other remained scrawny and had hair



that was thin and short and ugly and yellowish, and had eyes that were half-closed and dull.

You need plenty of food and the proper kind of food if you expect to grow and be happy. You need six different kinds of food.

You need proteins, and you can get these in meat and eggs and milk, especially.

You need carbohydrates, and you can get these very well in such things as potatoes and cereals and desserts.

You need minerals, and you can get these by eating vegetables like spinach and carrots, or fruits like apples and berries. Milk helps you get these, too.

You need vitamins, which come especially in fresh fruits and vegetables and in eggs and butter and cod-liver oil.

You need some fats also, although not too large a quantity. You can get enough of these by drink-

WHAT HAPPENS WHEN YOU EAT

ing milk and taking just an ordinary amount of butter.

And last, but not least, you need water, and plenty of it. And the best way to get plenty is to see that you drink at least four to six glasses a day.

IV. What Happens When Your Heart Beats

When you put your hand on your chest over your left nipple you know how you can feel a sort of lub-dub, lub-dub going on inside?

When you put your ear against some one else's chest and listen, why, you hear the same sort of lub-dub, lub-dub going on. You can try it with anyone, and you'll always hear that same gentle, steady sound.

One boy who listens, laughs, and exclaims, "Oh, there's a man playing a drum inside there."

But of course you know that is not the case. You know that it is the beating of the heart you are hearing.

The heart is continuously pumping, pumping. And if you've ever seen a water pump chug-chugging away, you know what a steady, busy job pumping is.

You may wonder what it is that this heart of yours is pumping so busily. Not water. You know that. But blood.

WHAT HAPPENS WHEN YOUR HEART BEATS

You remember how the food you eat is turned into liquid and goes into the blood. You remember, too, don't you, that in the blood it has to be carried to every part of the body? And so naturally the blood itself must go to every part of the body. The pumping of the heart sends it everywhere.

Jerry said, "I bit my tongue and blood came trickling out."

Jean said, "I pricked my finger and it bled."

And John chimed in, "I stepped on a piece of stone once. It was sharp and it cut my foot, and lots of blood came."

That was because the heart had pumped blood to each of these parts, just as it pumps blood to *every* other part of the body, inside and out.

"But," questioned Jerry, "how does the blood get to the heart?"

It might run through a pipe. It might run through a hose. And that is practically what it does. It runs to the heart through soft hollow tubes called veins. And then it is pumped out from the heart again through other tubes called arteries.

This is somewhat the way it works: Suppose

MY BODY AND HOW IT WORKS

your heart is sending blood, for instance, to the thumb of your left hand. It pumps out blood, lub-dub, into the big artery tube leading toward the left side of your chest and shoulder and arm. The blood runs in this big artery up to about your arm-pit. Then the artery branches off into a smaller artery that carries the blood down along your arm. This smaller artery branches out again and again—a section of its leads to the inner tissues, a section leads to the outer layers. Smaller and smaller branches go to each finger and also to your thumb. And there, tiny thin branches—as fine as hairs—lead to sides and tip and top of the thumb. These tiny branches are called capillaries. They carry blood even under your thumb nail.

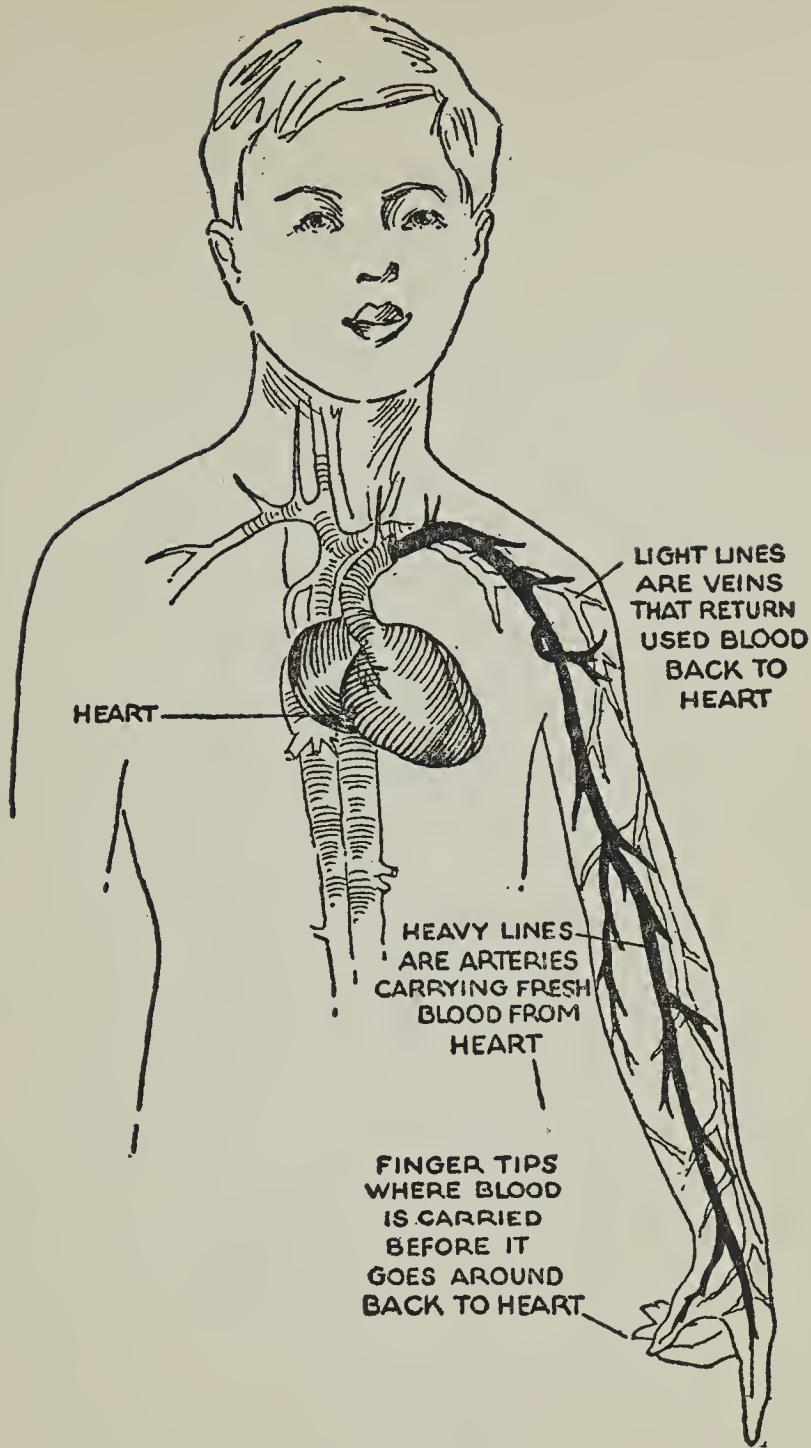
“And then where does the blood go?” asked Jerry.

Jean looked serious. She examined her thumb, “It can’t come out,” she said; “there’s no hole.”

“Perhaps it gets lost in there,” suggested John. But no—it neither comes out nor gets lost.

It goes back again to the heart.

How?



How the Blood Travels

MY BODY AND HOW IT WORKS

Why here again there are branching tubes to carry it back. They are called the veins.

If you look at your wrist, palm of your hand up, you will see some little blue lines. Here are showing some of the veins that carry the blood back to your heart. Perhaps you can see veins, too, in the palm of your hand and up along the inside of your elbow. The arteries that carry the blood away from the heart are deeper in. You can't see them.

The blood in the arteries is fresh blood. It is bright, brilliant red. But when the body parts use up what they need from the blood to help them work, it no longer is fresh. It loses its bright red color. It is *used* blood and it turns purplish and darker, and shows blue through the skin.

The blood really goes around the body in sort of irregular loops. If you stretch out your arm shoulder high, you can imagine a sort of loop drawn from the heart down your arm to your thumb and around and up your arm again and back to your heart. You can imagine the same sort of loop down to your foot and back to your heart.

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And the same sort of loop up to your nose, for instance, and back to your heart.

The blood circulates in such loops everywhere through the body. Out from the heart goes the fresh red blood through the arteries. Back to the heart goes the used purplish blood through the veins.

You can imagine that heart of yours down in your chest—about the size of your two fists held together—receiving blood and pumping it out again—receiving and pumping, receiving and pumping—lub-dub, lub-dub, over and over.

We seldom lose any large amount of blood. Unless we have a very deep cut, not much escapes. For there is something right in the blood that closes up most cuts by making the blood turn hard and dry quickly into a reddish, brown clot. You know how it does. It forms into a scab that stops the blood from running out of the cut place, just as a cork stops medicine from running out of a bottle.

There are other substances in the blood, too. The blood, you see, is not just red water. For one thing, there are cells in it.

MY BODY AND HOW IT WORKS

There are different kinds of cells in the blood. There are some that are called white corpuscles.



The white corpuscles have several kinds of work to perform for our bodies, just as you probably have several kinds of work which you perform for your home—like picking up your clothes from the floor so that the room looks tidy, or like making your bed in the morning.

One of the most important kinds of work the white corpuscles do is to fight the germs that come along trying to make us sick.

Germs are tiny things. We need a microscope to see them just as we need a miscroscope to see cells. Yet even though tiny, germs can do miserable and nasty things to us. They can give us measles and colds and coughs and other diseases. And they would give us diseases much more often if it were not for those little white corpuscles.

You see, as soon as a germ comes along, a white

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blood corpuscle swims right up to it and grabs it and eats it up.

Suppose the kind of germs that give you one of those horrid, sneezy colds were to come your way. They are so tiny, you know, that you would never see them. They would sneak up, as it were, through your mouth and nose. But they would not go very far before a whole army of white corpuscles would come rushing along to attack them. There would be a terrific fight. The germs would try to destroy the white corpuscles. The white corpuscles would try to destroy the germs. If the germs won, then you would have a cold until more white corpuscles gathered together into a bigger army.

“‘You get out of here! You get right out!’ That’s what the white corpuscles would be yelling at the germs if they could talk,” put in Jerry.

“I’d root for the white corpuscles, all right,” added Jean.

“And I would, too,” cried John.

You can’t see those white corpuscles, nor can you root for them, but if you are sick you can help them to be much stronger fighters by taking extra

MY BODY AND HOW IT WORKS

rest. That's why you stay in bed when you have a cold. By resting you are storing up strength to aid the white corpuscles in their battles against the germs, whereas were you up and running around, you would be using this same strength for doing things.

In addition to the white corpuscles there are also other kinds of cells in the blood. There are red corpuscles. They carry air to all parts of the body. For even the most inside parts of you need air, or at least a certain something that comes in the air, called oxygen.

And there are other sorts of things in the blood as well as these red and white corpuscles. For one, there is the digested food that is being carried to different places and about which you already know.

The blood performs so many important services for your body, that it needs a helper. This helper is another fluid, called lymph.

No wonder the blood needs this helper, when you think of the many services it does for us! It serves as a delivery wagon, since it carries food and oxygen to every place where they are needed.

WHAT HAPPENS WHEN YOUR HEART BEATS

It serves as a heater because it helps to keep the body warm. And, as you recall, it serves as an army of soldiers to keep us well, for it battles with the germs that threaten our health, and it overpowers and destroys them.

V. What Happens When You Breathe

Have you ever shut your mouth tightly and then made yourself take deep breaths—in and out, in and out, through your nose? Of course you have. But try it again. Breathe in and out, in and out. You may think that your nose is the only part of you that is working as you do this. But you are wrong. Other parts are working, too.

If you want proof, put your hand on your chest. Now breathe again. In and out. There! Do you feel your chest moving up and down? It does that because certain parts inside under your chest are working steadily as you breathe.

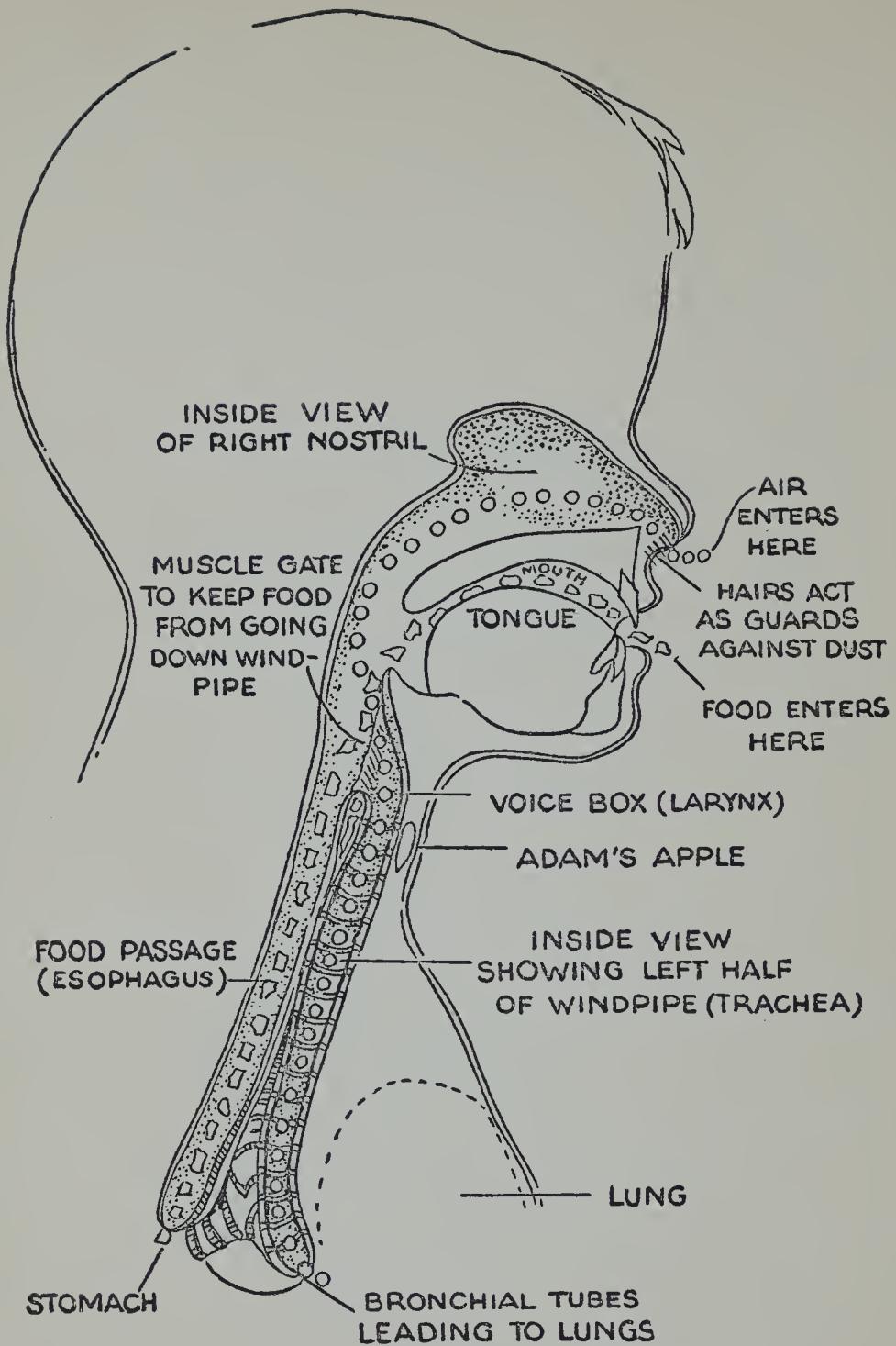
The air, as you may know, can go in either through your nose or through your mouth. But for several reasons it is better for it to go in through your nose. In the first place, there are tiny hairs in your nose that filter the air as it passes through. The hairs act as guards that stand at the gate and will not let dust or dirt go by. In the second place, because your nose can smell, it

WHAT HAPPENS WHEN YOU BREATHE

can give warning of air that is not fresh and good to breathe in. It smells a horrid smell, for instance, and you say: "Goodness! I don't like this kind of smell! This is a close, stuffy place. I'm going to get fresh air." And you open a window and let fresh air in.

The two air tubes that run up inside your nose you call nostrils. They do not end at the top of your nose, even though you may think they do. For a long time Jerry thought they did. But one day he found out definitely that they do not. This is how it happened. Jerry had a cold. So his mother said to him, "Lie down, Jerry, and I'll put some drops up your nose."

So Jerry lay down. He made a frown and a scowl and a pout about it, it's true, but, anyway, he lay down. And his mother dropped in the drops. And Jerry said, "Ugh! Nasty." And then in a few seconds Jerry said, "Funny, I can taste those drops in my mouth." And then in a few seconds again Jerry added, "There must be a path that leads from the top of my nose to the back of my mouth."



Air Passages

WHAT HAPPENS WHEN YOU BREATHE

And Jerry was right. There is. And the same path leads on down into the throat.

So when you breathe, the air goes in through your nose and down past the back of your mouth down your throat.

“Where my food goes?” cried Jean.

“Down into my stomach, just like my food?” questioned John.

But no. The air goes down for a short distance only in the food tube. For, you see, inside the throat there happens to be another tube, an air tube called the trachea, or windpipe. A portion of it is ordinarily called the “Adam’s apple.” You can feel this portion very clearly with your hand. This is an interesting spot because directly in back of it there lies your voice-box.

When you swallow food, a small gate made of muscles closes so that food does not slip into the windpipe. But when you breathe, this same gate stands open for the air to pass.

Sometimes, however, when you are swallowing food, the gate doesn’t close just exactly quickly enough and a crumb or something does slip into your windpipe, and then you cough and cough

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until the crumb comes up out of your windpipe and goes traveling on down the food part of your throat where it belongs. "Oh my!" you say, when you finish coughing, "That was awful! A crumb went down my wrong throat."

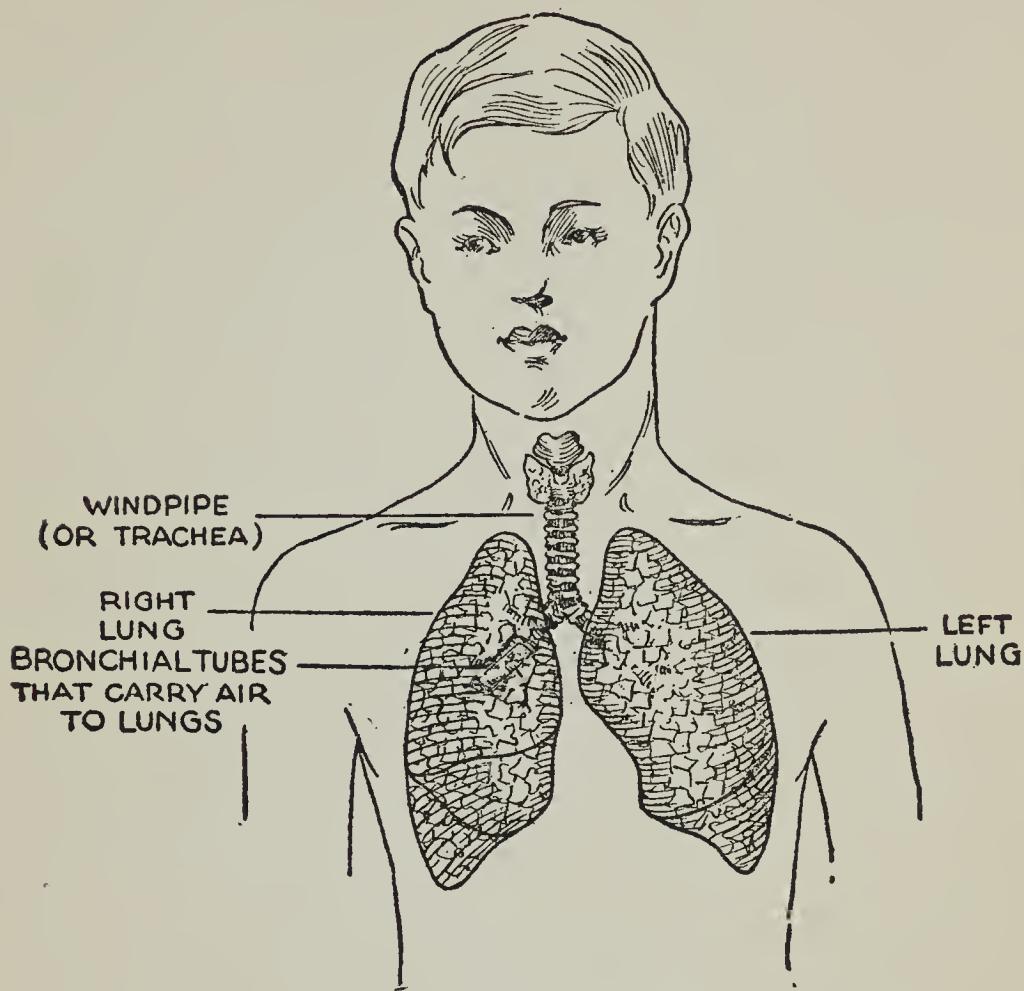
That was more or less what did happen. The crumb tried to go down the wrong part of your throat. At least, it tried to go down the front passage which is meant for air, instead of down the passage nearer the back of your neck which is meant for food. But it didn't get very far. You coughed and up it came. For air, and only air, may properly go down the windpipe.

The windpipe in turn opens up into other tubes called bronchial tubes. These branch out and branch out like the branches of trees and lead in their turn into the lungs.

The lungs are like two big sponges with the branches of the bronchial tubes stretching into them and running all through them. They take up practically the whole space in your chest, from side to side, from front to back. When the lungs fill with air they grow larger, much the way sponges grow larger when they fill with water.

WHAT HAPPENS WHEN YOU BREATHE

And when the lungs let the air out, they grow smaller, much as a sponge does when you squeeze water out of it.



A double sack surrounds the lungs. This keeps the air from escaping in ways that it is not meant to. It also protects the lungs from bumping up against your bones.

The bronchial tubes that carry the air down

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into the lungs are not the only tubes that open in the lungs. There is a big vein that brings blood to the lungs and a big artery that takes blood away. The blood brought by the vein is used blood which is needing a fresh supply of oxygen from the air. So it comes to the lungs to get this oxygen, for the lungs always have ready a supply of fresh oxygen that has recently traveled all the way down to them from your nose where you breathed it in.

After the blood has taken the amount of air it needs from the lungs, it flows into the artery and goes through the artery to your heart. Then your heart pumps it out again all over your body.

The lungs, you see, are like the cleaning-plant for the blood. They renovate and clean it. The heart, on the other hand, is like its pumping-station.

When you do certain things, you need more air than when you do others. When you run, for instance, you need more air than when you walk.

When you talk or sing, you need more air than when you keep silent. If you ever have a chance to watch a singer closely, you will notice that deep

WHAT HAPPENS WHEN YOU BREATHE

breaths are taken especially before the loudest and highest notes. The singer needs air to make his voice come out loud and full. All our voice sounds depend on taking in air. It's the way the air acts against the voice-box that makes our words sound when we talk.

The voice-box isn't a sort of gramophone down inside your throat. It's nothing but a particular part of your air tube, made of muscles and cords which act in certain ways that make sounds when air comes against them. And so when you are talking or singing, you need a greater supply of air than when you are thinking quietly.

"But I never think of taking in more air," exclaimed Jean.

One does not have to think to do it. It just happens! When one needs more air, one breathes it in automatically without thinking about it at all. Down near where your ribs end, under your chest, there is a sort of dome-shaped shelf that stretches straight through you, from front to back, from side to side. It is a strong shelf, made of muscles that can move up and down, up and down. It is called the diaphragm. This diaphragm

MY BODY AND HOW IT WORKS

moves more slowly up and down when you need only your usual supply of air—about twenty times a minute. But when you need a larger supply of air it moves more quickly and makes you breathe more quickly without your ever having to think about it.

Once a foolish boy said: “I’m not going to let that diaphragm inside of me make me go on breathing. I’m going to stop breathing if I want to. I am. I’ll hold my breath.” And so he tried. He took one great big deep breath and he held it and he held it and he held it. And then, all of a sudden, he found that he could not hold it any longer. He simply *had* to go on breathing. And it was lucky that he did, for his body needed to have air pass in through his nose and circulate all through every part of it, just as does your body and everyone else’s.

VI. What Would Happen to You If You Had No Bones?

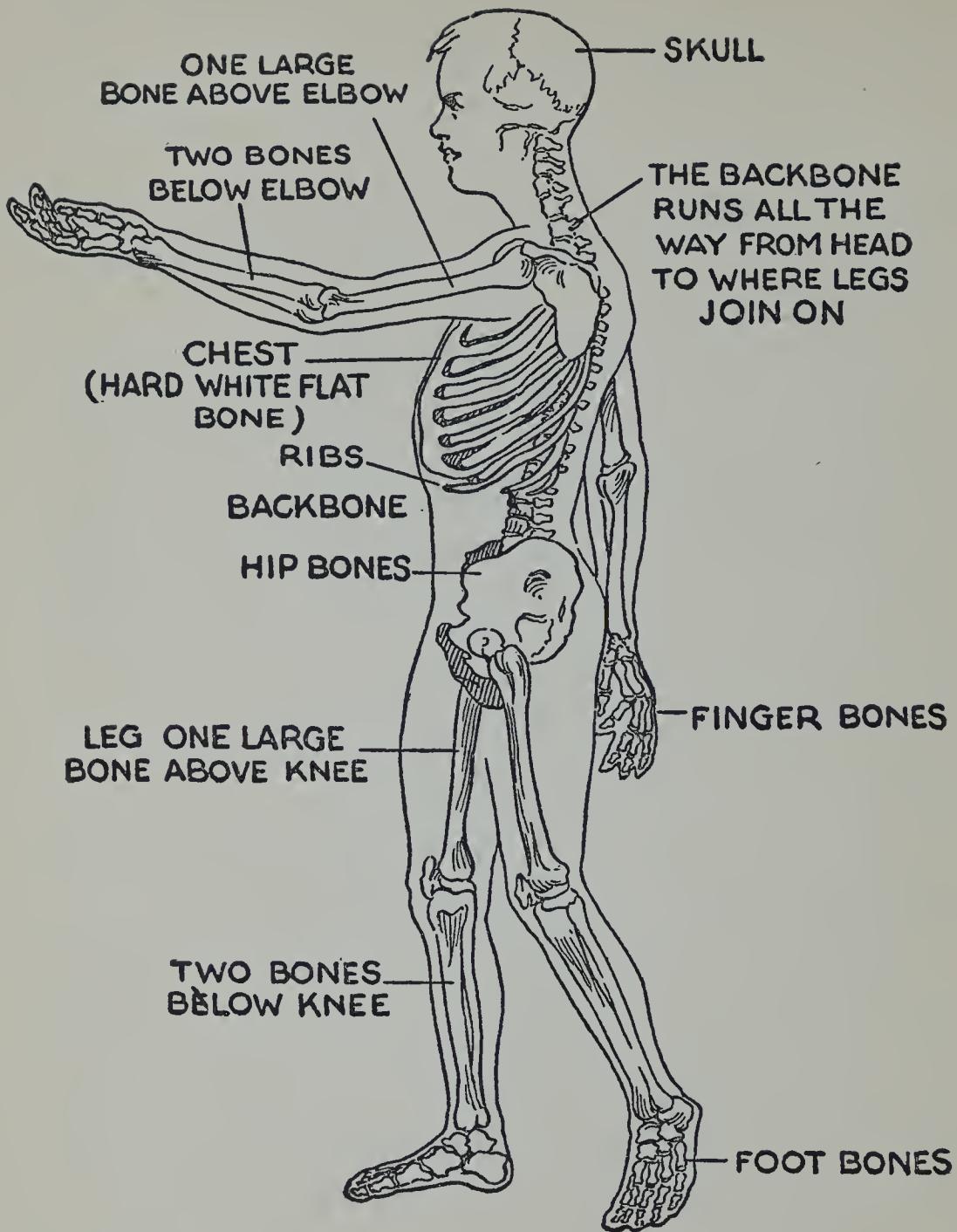
Jerry was acting silly. He was jumping up and down and shouting at the top of his voice: "I have no bones! I have no bones!"

But if Jerry had had no bones, he would not have been able to jump. He would not have been able to stand. He would have slumped down all into a heap—more shapeless by far than any rag doll you've ever seen. For the bones hold the body up. They give it support.

There is a framework of bones from the top of your head to the toes of your feet.

Feel your head. It is hard. For under the hair and skin there is a hard white bony skull.

Feel the back of your neck. You will notice hard little humps. Those are parts of your backbone. By following them you can follow your backbone all the way down your back—down and down until it ends at the place where monkeys' tails begin. Monkeys' tails, in fact, are the endings of their backbones. Wouldn't it be funny if ours,



The Bony Skeleton

IF YOU HAD NO BONES

too, ended that way? We might go around then with pink ribbon bows on our tails as ornaments, and wag our tails for pleasure while eating candy.

Feel your chest. Yes, there is quite a large flat bone down the middle of it.

And feel around from the middle, between your nipples and down a little bit lower. Feel around and out toward the sides and on around toward your back. Do you notice how the bones inside there hoop around from the front in a sort of half-circle right to the backbone behind? Those hooping bones are your ribs. They can move up or down, and so give your lungs a chance to stretch and become larger as they fill with oxygen.

Then feel lower down. Poke around your abdomen. No bones there. You're right. But go a little bit lower. How about those hips? Yes, indeed. Hard hip bones, it's true, big bones that reach all the way through to the back, right to where the backbone ends.

And feel in either leg. A fine strong bone runs from your hip to your knee. It's padded well with muscles and may be difficult to feel. Nevertheless, it is there, all right. And from your knee two

MY BODY AND HOW IT WORKS

other bones run down straight to your ankle, where the foot bones join on.

And your arms, too. One bone at the top, from your shoulder down to your elbow. Two bones from your elbow to your wrist, and from there on, the bones of your hand. In your fingers you can feel the bones very plainly.

“My finger-bones bend,” exclaimed Jean, “they bend in three places.”

Jean thought that the bones themselves bent because she did not yet know that the bending-places are where one bone ends and another one begins. Nor did she yet know that the places where two bones come together and fit against one another are called *joints*. The joints in your fingers are called knuckles. The joints in your arms are at your elbows and wrists, the ones in your legs at your knees and ankles.

The joints are made in such a way as to allow us to move freely. You can now open and close your hands easily. But if your hands were not provided with joints, you would only be able to keep them stiffly straight. In the same way the joints at your elbows make you able to bend your

IF YOU HAD NO BONES

arms, the knee joints make you able to bend your legs, and so on all over your body in the many bending-places.

“But,” wondered Jerry, “how is it that my shoulder lets my whole arm swing every which way, and my elbow lets my arm bend at the inside only and not at the back?”

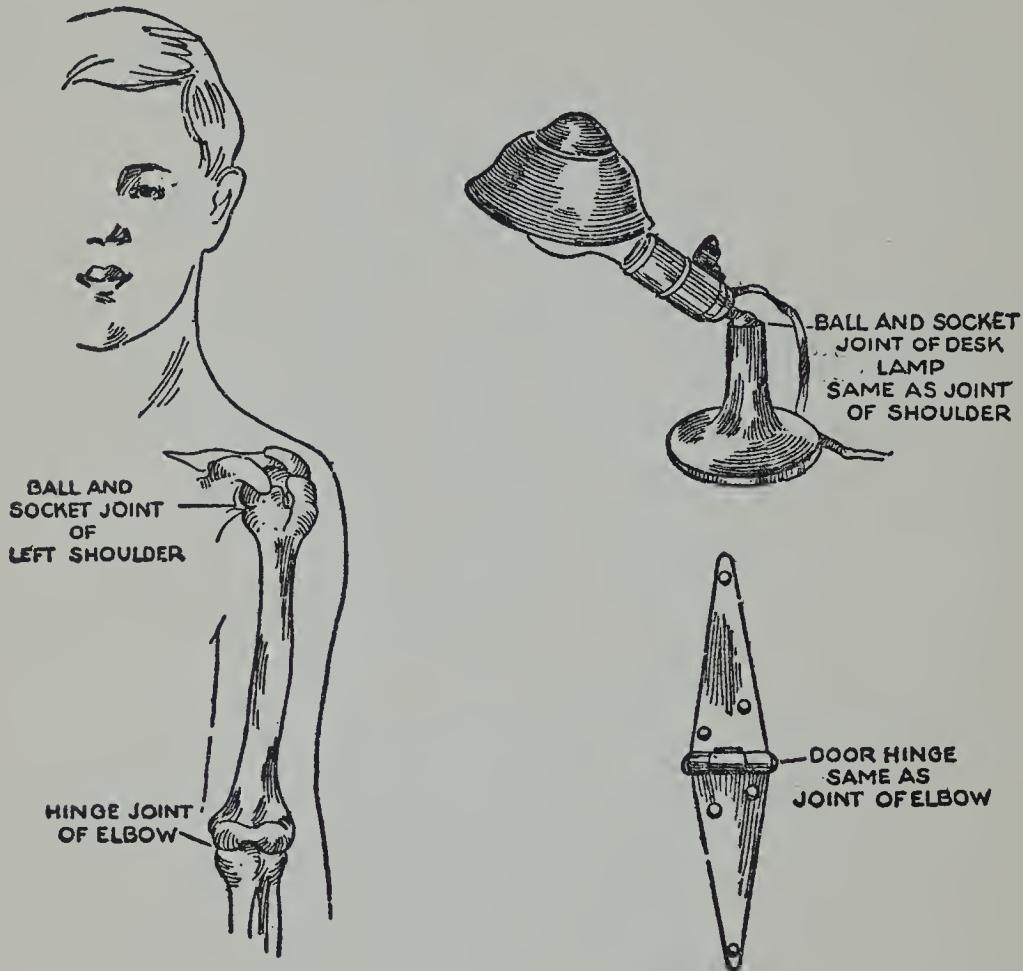
The ends of the bones fit together in different ways. At the shoulder, for instance, they fit together like a ball fitted into a socket. You’ve seen the same sort of arrangement on desk lamps that can be swung around in every direction. But at the elbow the bones fit together like the hinge of a door that can open out in one direction but not in the opposite one.

Like hinges too, your joints need oiling to keep them from becoming stiff and creaky. For this reason there are oil glands at all the joints to send oil out to lubricate them as they need it.

Jean wanted to know if the ends of her bones were softer than the middle. “You know the way gristle is softer at the ends of chicken bones. You can chew it!”

MY BODY AND HOW IT WORKS

There is no gristle at the ends of all our bones, but we have the same sort of gristle at certain parts of us, as, for instance, at the ends of our ribs. The gristle enables these parts to curve more



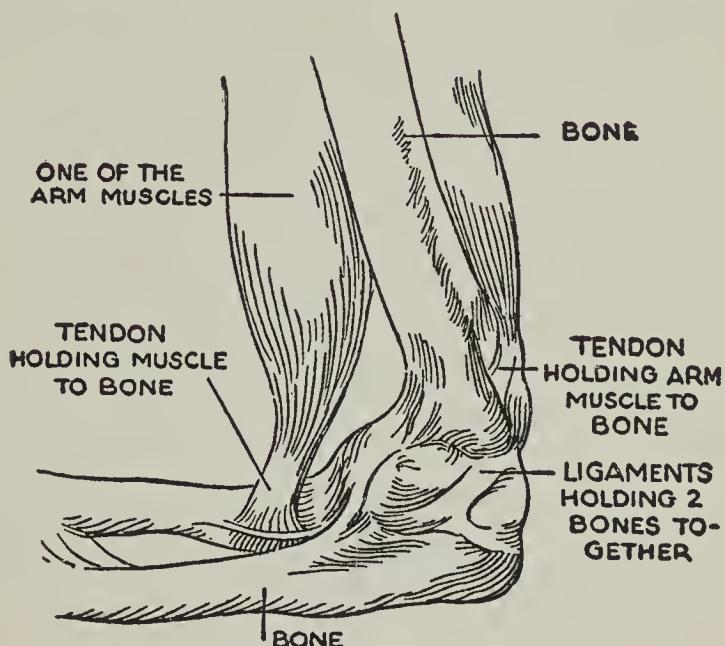
easily without breaking. Our gristle is called cartilage. You can feel it at such places as in your ears, or at the end of your nose.

Then Jerry looked thoughtful and questioned,

IF YOU HAD NO BONES

“But what keeps my bones from slipping out of place?”

Bones are tied firmly in place by tough stringy bands called ligaments. These reach from one bone to the next and hold them together. Then, as a still further safeguard, there are other stringy



bands called tendons, which fasten the bones to nearby muscles and so help them stay even more firmly in place.

Suppose you had no bones. You would just flop down, as has already been mentioned. And having flopped down, you would not be able to move along with free firm strides on legs well-supported

MY BODY AND HOW IT WORKS

by bones. And beside that, anyone could come along and squeeze you, say around your chest where your lungs and heart are, and if there were no hard bones there to keep you in shape and protect you, the squeezing person could hurt your insides. And, pouff! there you'd be, a sorry mess!

John looked thoughtful. "I'm glad I have all my bones," he said.

Jean wanted to know how many bones she had. They started guessing.

"Twenty-one?"

"Thirty?"

"Fifty-nine?"

"Eighty?"

And even Jerry was astonished to learn that there are *two hundred and six* bones in the body.

VII. When You Move

Jean and John and Jerry one day went to the circus. They saw a strong man there. They stood and watched him lift a cow right off the ground as easily as if the cow had been a dog.

People all around were exclaiming, "Isn't he strong, though?" . . . "Just see his muscles, will you?" . . . "What muscles!"

His muscles bulged. They stood out in knotty humps at his shoulders, on his arms, on his legs.

"Feel how hard the strong man's muscles are. Anyone can come and feel them. Hard as iron. Hard as steel," called a man from the platform.

Jerry and John had to feel them.

"Hard as iron, hard as steel, hard, strong muscles."

That evening when John was taking his bath he stood in front of the mirror. He clenched his fists, he lifted his arms, as he had seen the strong man do. And then he gave a grunt of disappointment, "Shucks!" he exclaimed. "I guess I haven't any muscles."

But that was foolish, because all of us have

MY BODY AND HOW IT WORKS

muscles. It's true not many have them as well developed and hard as the strong man's, but we have them, none the less.

The muscles are the parts of us that help us most when we move.

If you stand on one foot and stretch your leg up and then straighten and bend it, you may know that it is the muscles under the skin that pull the bones in your leg apart and together, apart and together. For the muscles are attached to the bones and pull and stretch as the need is, to make us move.

Muscles can stretch and contract somewhat as an elastic band does when you pull it and then let it snap back.

When you throw a ball, there are many muscles in your shoulder and back and chest and arm and hand working to make the motion.

When you close your eyes and open them, there are delicate little muscles working to move your eyelids.

When you dig in the garden, or pull up the window shade, or comb your hair, there are mus-

WHEN YOU MOVE

cles working. No matter how you move, as soon as you move there are muscles working.

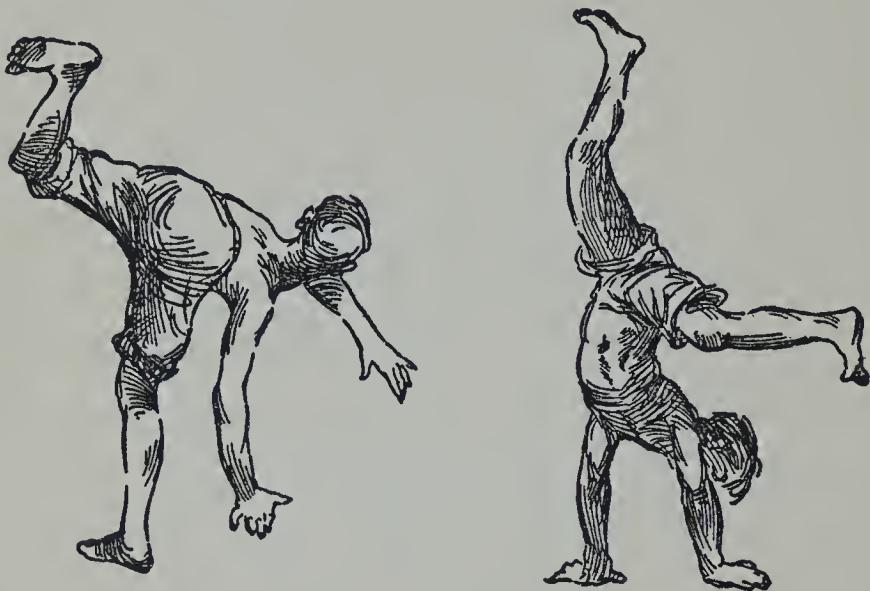
You can feel many of the muscles of your body, even though they are not lumpy and hard like the strong man's, for you can feel the flesh that stretches all over you under your skin, and what you call flesh is really muscle. You can feel it along your arms and shoulders, across your chest and abdomen and back, across your lips and cheeks and neck, and most of all in your buttocks and legs, where there are great, strong muscles that you use continuously in moving about.

You can make the muscles that stretch all along under your skin work for you at will. When you want to throw a ball you make your muscles work to do it. When you want to raise the shade or shut your eyes, again you make your muscles work. And so, because you can make them work at will in this way, these muscles are called voluntary muscles.

There are other muscles deeper inside of you, however, that you can neither feel nor make work as you will. The heart and stomach, the intestines, and various other organs are made of such mus-

MY BODY AND HOW IT WORKS

cles. When the heart beats, then, the heart muscles move. When the stomach churns the food, the stomach muscles move. They work, not when we will them to, but whenever it is necessary for them to do so. For that reason they are called involuntary muscles.



The voluntary muscles, under the surface of our skin, can be developed and made stronger by exercising and using them. Swinging, running, skating, riding, swimming, walking, throwing, pushing, and pulling—these and many other forms of exercise strengthen our muscles.

When John heard this he immediately made up his mind to develop his muscles right away

WHEN YOU MOVE

so that they would grow to be just as bunchy and hard as the circus strong man's.

"I'm going to exercise every single minute of today," was what he decided to do.

And so he started in. First he walked around the block and then he ran. He walked and he ran and walked and ran, until he grew bored with walking and running. Then he went to his swing. He swung and swung and swung, until he grew bored with swinging. Then he commenced turning somersaults and doing handstands. But right in the middle of the third handstand he flopped over. His muscles would not work any longer.

"Goodness!" he exclaimed. "Here I've been exercising and exercising to make my muscles work better, and they won't even work as well as they did."

He couldn't understand this at all until he finally found out that actually he had grown *too tired* for his muscles to work well. All he needed to do to make them work properly again was to rest, and after that not to exercise quite so long and hard at a stretch.

MY BODY AND HOW IT WORKS

Being tired always keeps our muscles from working as well as they would otherwise. If we stay up too late at night, we'll probably find that because we're tired we can't do things as well the next day. Or if we do something very unusual, like going up in an airplane, we'll probably find that the excitement tires us, and for a while, until we're rested again, we won't be able to do things so well.

Going hungry, too, keeps our muscles from working properly. Eating too little or eating the wrong kind of food weakens them. Failing to get rid of the undigested part of the food we eat also keeps our muscles from doing their work as they should. That's one reason why having a bowel movement each day is so important.

John found out all these facts about muscles. And he also found out that strong men do not become strong in one day or in two days or in five weeks, but only through eating properly and resting properly and exercising sufficiently day after day, and week after week, and month after month, and year after year, the whole time they are growing up.

VIII. When You Light the Light in the Dark and When You Do Some Other Things

You have probably at some time or other needed to get up out of your bed at night and light the light in your room for some reason or other. When this happened you probably lay in bed and thought: "Now, I have to get up. It's dark. I'll want to see, so I'll light the light." And then, most probably, you've gotten up and have walked right straight to the part of the room where the light clicks on, and have found it without much trouble by feeling around a bit with your hand along the wall. When your fingers felt the switch you probably exclaimed to yourself, "Well, here it is," and you moved your fingers in just the right way to turn on the light.

Now what was it that made you able to know that the room was dark and that you wanted the light on in the first place? And then what was it that made you remember that the switch was in a certain part of the room? And what was it

MY BODY AND HOW IT WORKS

that made you able to control your feet so that they would take steps directly to the right part of the room? And what made you able to have your hand do what you wanted it to and reach up to the switch? And what made you know, when you felt the switch, that it was a switch and not a dog's nose you were feeling in the dark? And then, finally, what part of you sent a message to those fingers of yours that now, at last, it was time for them to do their work and to click on the light?

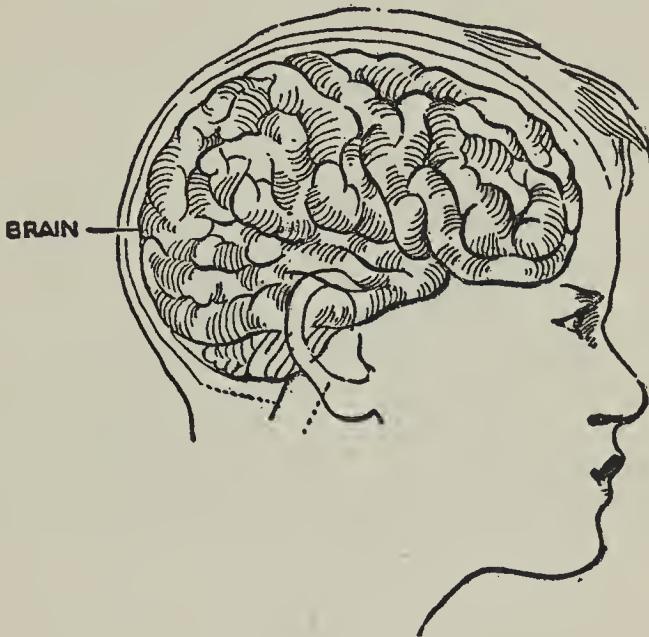
Most mysteriously, but in some way which no one understands, that part of you called the nervous system made it possible for you to do all these things.

Inside of that hard skull of yours, filling the top and back part of your head, lies your brain. In some way or other the thinking that you did about needing to get up, and the remembering you did as to where the switch was, took place with the help of that brain.

In front of the backbone that runs from your head right down, there lies a groove which contains a cord of nerve tissue. This is called the

WHEN YOU LIGHT THE LIGHT IN THE DARK

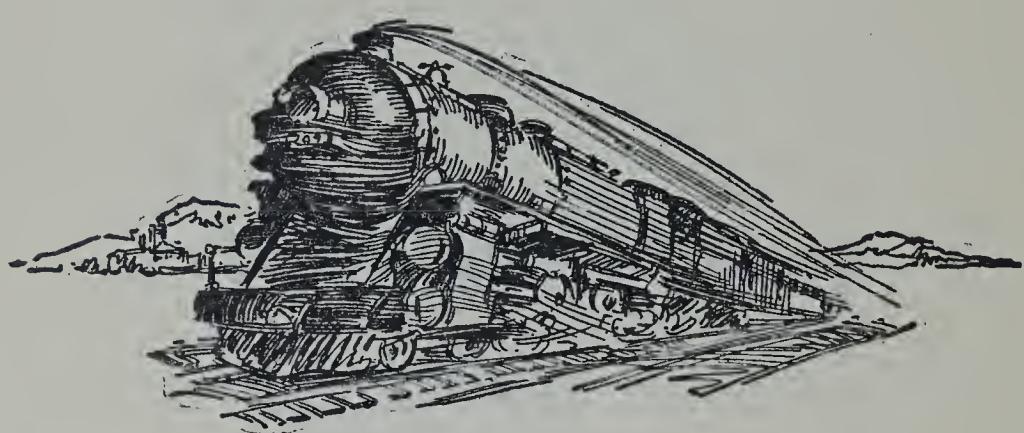
spinal cord. From this spinal cord branch out many smaller grayish white strands called nerves, which in turn branch and branch into smaller and smaller threads and so go to all parts of the body. In some unknown way messages travel along



these nerves, so that when you remembered, with the help of your brain, that the light switch was in a certain part of the room, messages ran from your brain to your feet and told them to step toward that part of the room. And when you had reached the right part of the room and knew so because of your brain working as it does, messages again traveled down to your hand, giving it word

MY BODY AND HOW IT WORKS

to start lighting the light. Your hand in turn was only able to feel the switch because of the nerves in your fingers. Messages then went all the way up from your fingers, along the nerves in your arms, to the big nerves in your spinal cord, and up to the central station in your brain. In the brain the message probably registered



something like this, "Here's the light switch, right here." And then quicker than lightning messages went down from the brain, down the spinal cord and out to the fingers, signaling them to switch on the light.

Messages are continuously traveling along the nerves. All kinds of messages. You look at a great black engine tearing by. A message goes from the nerves in your eyes up to your brain and your

WHEN YOU LIGHT THE LIGHT IN THE DARK

brain registers: "That's an engine. It's black. It has six wheels." The engine whistles. Messages go from the nerves of your ears to your brain, and your brain registers the shrill sound so that you are conscious of hearing it. Perhaps you are standing a bit too close and you feel a great wind in your face. Messages go from the nerves of your face to your brain, and your brain registers, "Too near. Better stand back." And messages run down to your legs and feet to move a few steps farther away from the train.

As you can see, the brain serves as the central station for receiving and sending messages. There are other, smaller stations, though, for some sorts of messages. These sub-stations are called ganglia. They are found in certain locations all over the body. Many of them lie along the spinal cord. Suppose you were to turn on the bath water and put your finger under the spout to feel how warm it was, and it happened to be very hot. The message that the hot water was hurting your finger would race along the arm nerves to the spinal cord, and another message for jerking the finger away would race directly back.

MY BODY AND HOW IT WORKS

Of course, a message about the hot water might also go up to the brain so that the brain could help you remember to be more careful next time. But the jerking away would have been done, anyhow, without the help of the brain but with the help of the spinal cord alone.

Another kind of message, too, is sent within the body by a special part of the brain. These are the automatic messages that control the blood vessels and organs like the lungs and heart and stomach. They travel over different nerve strands called automatic or sympathetic nerves. For instance, when we pick up, or even look at, a delicious candy, messages go down to the stomach for it to get ready to spread digestive juices over the candy, and the messages make the stomach start the juices flowing before the candy itself gets there, so that the juices are prepared to digest the candy when it arrives. We are not at all conscious of these automatic messages, however. They are different in this way from the other sorts of messages that have to do with the feeling and seeing and hearing and smelling and tasting and moving that we are conscious of.

WHEN YOU LIGHT THE LIGHT IN THE DARK

If it were not for our brain and nerves we would not see anything, we would not hear anything, we would not be able to taste or smell or feel whether things were soft or hard or rough or smooth. We wouldn't be able to recognize people or objects. We wouldn't know that a mouse was a mouse and not an elephant, or that a carrot was good to eat, and a piece of mud no good. We wouldn't be able to move about as we wish, to do the things we want to do. We wouldn't be able to learn to read or write, nor would we be able to learn even such simple things as buttoning our clothes. We wouldn't be able to talk. We would be very much like plants that just grow without sense, without sight, without sound, without being able to move here and there.

Without our brains and our nerves we wouldn't be human beings, and living would not be nearly so worth while.

IX. When You See Things

When you look at a little fuzzy white animal with pink eyes and long white ears and a bit of fluff for a tail, you immediately say, "There's a rabbit."

When you look at a great gray animal with wide waving ears and a long gray trunk in front, you immediately say, "There's an elephant."

When you look up at the ceiling and see a black spot crawling slowly along across the room, you say, "There's a fly walking upside down."

But suppose you shut your eyes. Could you see the rabbit or the elephant or the fly? No, of course not. You need your eyes to help you see.

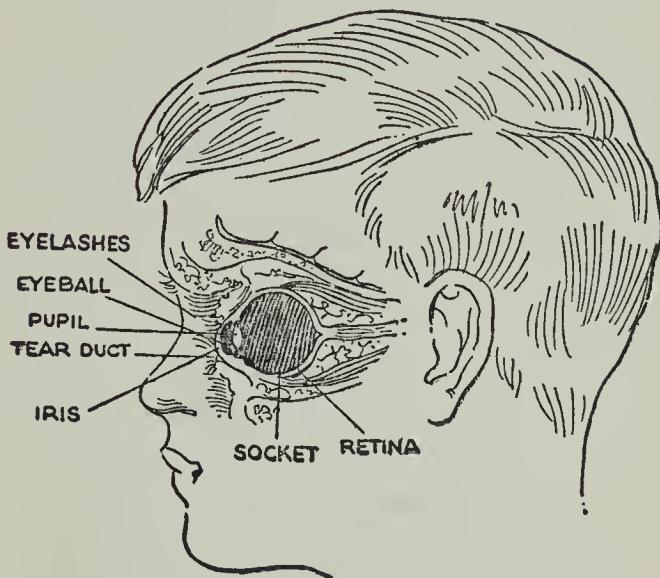
The eye is a round ball set in a socket designed especially for it to fit into. You can only see a small part of the ball when you look at another person's eye.

As you have probably noticed, everyone has a colored part to his eyes. This colored part is called the iris. Some irises are gray, some are brown, some blue. If you look carefully at different people's eyes, you will notice many lovely color combinations in the irises. Jerry noticed that

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John's irises were almost golden yellow spotted with tiny brown flecks.

Right in the center of the iris you have doubtless noticed, also, that there is a black circle called the pupil. The pupil really is a hole—yes, a little round hole. You do not ordinarily realize this,



however, because the entire eyeball is covered over with a transparent coating, and when you look at eyes you see the pupil through the coating, just as you might see a room through a glass window. This coating is most necessary, for it protects the delicate parts of the eye that help us see. If there were no coating, any bit of dust might come along and fly straight through the hole which is called

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the pupil, where it would be very much in the way of our seeing clearly.

When you look at the rabbit, his image is carried by rays of light in through the pupil of your eye, and right on through your eyeball to a layer of nerve cells lining the back inside surface of the eyeball. This layer is called the retina. Here the most wonderful thing happens. The retina acts as a camera and makes a picture of a rabbit for your mind—not a picture on a piece of paper or on a piece of celluloid film, but a sort of “thought picture” without which you would not be able to know what the rabbit looked like. Then the nerves of the eyes telegraph this picture back to the brain, and only then do you really *see* the rabbit. But so clearly do you see him then, that you can even shut your eyes and remember what he looks like long after you have actually looked at him.

Every camera needs the right amount of light for making its pictures. The eye's camera, the retina, is no different. The light is carried in to it, as you know, through a hole, the pupil. Now, if

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you stand in the sun where the light is bright, at first you are dazzled and not able to see clearly. The light is so strong that too much of it is entering each of your eyes. So what happens? Why, automatically, the pupil contracts, the hole grows smaller and lets less light into the camera part of each eye, enabling you to see clearly once more. On the other hand, if you go into a darkened room, again you will not be able to see. The light is so dim that not enough is entering each eye. So this time what happens? Automatically, again, the pupil changes. This time, however, it needs to let in more light, not less, so, instead of contracting, it expands. The hole grows larger, letting in a greater quantity of the dim light, enough for you to see as clearly as is possible with such dim light. In other words, the pupil is made so that it can become smaller or larger to let in lesser or greater quantities of light, depending on the strength of the light. If you take a mirror into several places where the light is different, you will be able to watch the changes in the size of your pupils. Try it and see!

MY BODY AND HOW IT WORKS

Jean wanted to know, "What is the inside of the eyeball stuffed with, or is it just empty?"

It is not empty. On the contrary, it is filled with transparent watery fluid.

"Oh," said John! "And does that come out when you cry?"

At this Jerry laughed. He understood, for some reason, that the fluid inside of the eyeball could not possibly come out.

There is a little tiny hump under each eyelid, called a tear duct. Tears run out through these ducts from tear glands at each side of the nose under the skin where tears are manufactured. When anything flies into your eye, the tear ducts start working and your eye waters, and the dust or cinder or bug or whatever it may be, is washed out.

Your eyelashes, however, keep many things from flying into your eyes. They catch bits of dust, and keep tiny objects from drifting in. And the eyelids, too, help a great deal. You may not know it, but you just naturally shut your eye to protect it if something comes too close. You'll no-

WHEN YOU SEE THINGS

tice this if you make your finger go quickly past your eye. You'll feel yourself blink the lid closed.

"Why do we close our eyes at night?" wondered Jerry, and then guessed, "I suppose it's to rest them by shutting out the light."

And Jerry was right.

X. When You Hear Things

Jerry had a trumpet. He blew into it by the hour. When he blew hard, harsh loud noises came out. When he blew softly the sounds were very different.

“Oh,” said Jerry, “I use a different amount of air.”

The sounds you hear are different for a similar reason. They come to you with different amounts of air. Every single sound you hear is made up of air waves from the outside that travel into your ear somewhat the way Jerry’s air traveled out of his trumpet.

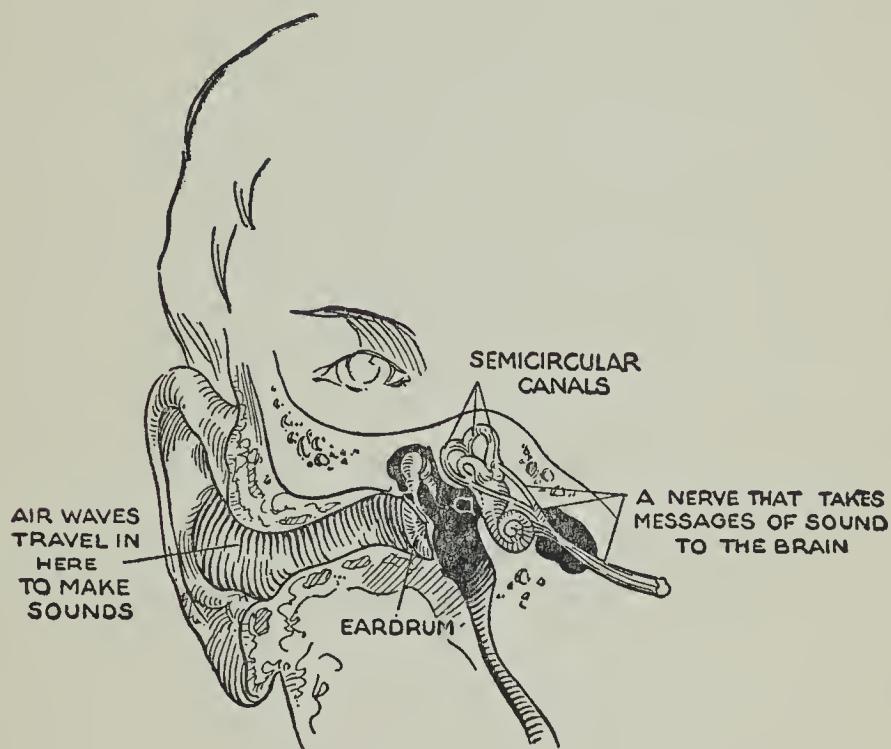
The air waves go in through the outside opening of your ear. They travel in along a passage until they come to a thin membrane, a sort of skin, and here they beat against the membrane much as you might beat with drumsticks against the skin of a drum. In fact, this membrane which the air waves beat against is called the eardrum.

Nerves take messages of the beats up to the brain, and there, when the messages register, you hear. You hear music, or some one calling you

WHEN YOU HEAR THINGS

to come in for supper, or some one saying there is a circus ticket for you, or the cat meowing, or the bird singing.

The ear drum is very, very delicate, so wax gathers in the ear passage to protect it, and tiny



hairs also help to keep flies and mosquitoes and other insects out and aid in collecting the dirt that happens to drift in.

Way inside the ear, though, there is a part of you that helps you to do something that has absolutely no connection at all with hearing.

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"That's funny," said John. "I thought ears made you hear, and nothing else."

This part of the ear, way inside, is made up of what are called the semicircular canals. These are filled with a kind of fluid. Their job is to help you keep your balance. They help you to keep steady instead of being all wabbly and shaky when you climb trees. They help you to balance yourself when you walk along a railroad tie or a walking-board. When the fluid inside them becomes disturbed, then you begin to be shaky and dizzy. Spinning around and around like a top does that to you sometimes. But the sensation does not last long, ordinarily.

"Not when your ears work properly," said Jean.

XI. Tasting and Smelling

Jean had been cooking. She loved to cook. She had just made a new kind of candy. She didn't know what name to give it. She had put all sorts of things into it, but she would not tell anyone what these were. "Guess," she said.

"I taste salt," said John.

John could taste the salt so clearly because accidentally Jean had put in a lot, and salt happens to be one of the kinds of taste we really do taste.

There are taste buds on our tongues—mostly on the back of them. Anything salty or sweet or sour or bitter can be tasted by these buds, which then send messages to the brain, which in turn register in some unknown way, so that we say, "This sugar is sweet," or, "This vinegar is sour," or, "This coffee is bitter."

Sweet and salty and bitter and sour tastes are the *only* tastes that are registered through the taste buds. Other tastes are registered through our smelling them. The messages about these are sent from nerves in the back of the nose to the brain.

When you say, "I taste onion," you really are

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smelling it with your nose, although you think you are tasting it with your tongue.

At times when you've had a cold you may have noticed that you couldn't taste things so well as



ordinarily. That was because your nose was stopped up and you were not able to smell properly.

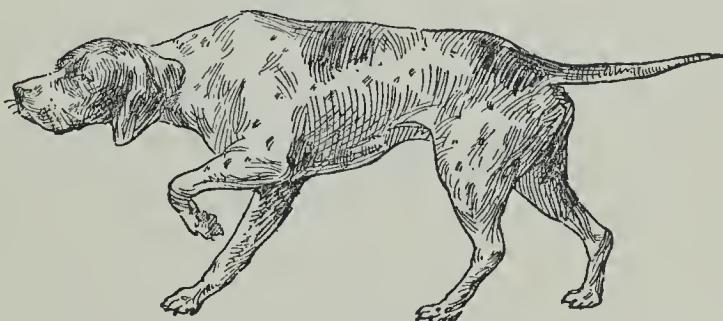
Of course you also smell other things that have nothing especially to do with taste. Delicious per-

TASTING AND SMELLING

fumes, for instance. Or the garbage man's wagon, which, as you know, is far from delicious.

Dogs and many animals use their sense of smell much more than people do. We may run away from the garbage-wagon, it is true, or try to find out where the good perfume smell comes from, so as to get closer to it, but we don't use our noses the way dogs do to locate bones, for instance, that they have buried in the ground, or to recognize one person from another by sniffing at him.

"My dog does that," exclaimed Jean. "He dashes up and sniffs and sniffs, and if you're a stranger he walks away and lies down or he barks at you hard, but if he knows your smell, why, then he jumps around you for joy and wags and wags his tail."



XII. Before You Were As Big As You Are Now

Can you remember yourself as you were two birthdays ago? Weren't you quite different from now? Were you as tall? Were you as heavy? Did you like the same sort of books and were you interested in doing the same things as now?

And before that, can you remember way back? There was a time when you couldn't talk or walk.

"I remember John when he was that way," said Jerry. "He could cry, though. Oh, how he could cry! He'd go waah, waah, waah by the hour."

"But he was such a cunning baby," put in Jean. "I used to help give him his bath. He'd spread his toes out into fan shapes when I washed the soles of his feet."

"He couldn't eat any meat or vegetables or anything hard. He had no teeth when he was a real tiny baby."

"No, he drank milk from a bottle."

"And before that he drank milk from mother's breasts."

BEFORE YOU WERE AS BIG AS YOU ARE NOW

“And do you remember the first day we saw him when he was brand new—soon after he’d been born? My, but he was little and red and wrinkled!”

All of which was true about John before he was as big as he is now. And so, also, is all of this true about you. You, too, were once a tiny, wrinkled, red newborn baby. That was just after you came out from the inside of your mother, where you had been growing for nine months.

You had been growing there in a special place inside of her called the uterus.

The uterus lies below the navel between the two hip bones. It serves as a strong, warm case for the baby to grow in—like a bag made of muscles. Ordinarily when no babies are growing in it, it is about as large as a closed fist, but when a baby starts to grow the uterus stretches and stretches in size to provide the baby with the room that it needs.

When the baby is lying in the uterus just before it is born, it is all curled up. Its knees are bent up close to its chest. Its arms are curved and folded over its chest. Its head is down, with chin

MY BODY AND HOW IT WORKS

almost touching knees. And, curiously, it usually lies upside down, its head nearest the opening, so that when it is born its head is the first part to come out.

"How does it come out?" asked Jean.

It travels from the uterus along a tube called the vagina, down and out between the mother's legs through the vagina's opening which can stretch so that it is large enough to let the baby through.

When you were a tiny baby just ready to come out, you looked like other tiny babies you have seen. But you did not look that way, like a regular baby, the whole time you were growing in your mother's uterus.

There was a time when you had no hair or nails. They were still to develop before you would be ready to be born. Before that you had no ears or eyes. They had still to develop. Before that you had no legs or arms. In fact, you did not look at all like a baby, but much more like a little curled, hairless caterpillar. And you were tiny, not even as long as your little finger.

And before that, before you looked like a tiny

BEFORE YOU WERE AS BIG AS YOU ARE NOW

caterpillar, you were even tinier, and looked like a little ball, a ball no bigger than a pin head. That was when you first started inside your mother's uterus, to grow into you.

But before you started to grow in your mother's uterus you were in two places instead of one. You can't ever be in two places at once, now, so that sounds strange. But it's true. One half of you was inside your mother even then. But the other half of you was inside your father. And it was not until the half that was inside your father had come to join the half inside your mother that you could begin growing and developing into a baby.

The half inside your mother was round in shape and very, very tiny—smaller than the head of a pin. It was called an ovum. The half inside your father was shaped something like a polliwog, with an egg-shaped front part and a long thin tail behind. Only it was much, much, much smaller than a polliwog, even smaller than the ovum. It was called a sperm.

The ovum had been stored for a long time with many other ova, inside your mother in one of two little sacs near the uterus, called the ovaries.

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It had only recently traveled from this sac down a tube to the uterus.

The sperm had been stored with many other sperm inside your father in one of two little sacs called the testicles. The testicles are inside of the skin sack which lies right below the penis and hangs down where the legs join on to the body. The sperm had traveled from the testicle through a tube to a small storage tank sort of place behind the penis. Here a fluid called *semen* had been supplied for the sperm to swim in. And here the sperm had stayed until time came for it to travel out. Then, on it had gone, out through another tube which runs down the center of the penis and opens at the end of the penis to the outside.

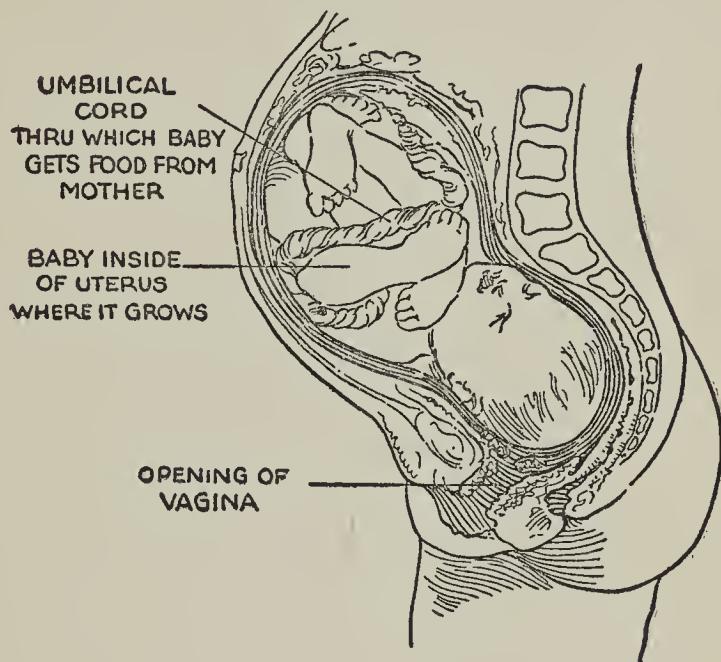
The sperm inside your father could never have developed into a baby by itself. The ovum inside your mother could never have developed into a baby by itself. The two had to come together before you could start growing.

This happened as it always happens when two people care for each other and want a baby. The sperm comes out through the end of the father's penis and goes up through the mother's vagina

BEFORE YOU WERE AS BIG AS YOU ARE NOW

to the uterus. Here it goes straight to the ovum and runs into it, joining with it in much the way that two drops of water join when they run together and make one single drop.

The egg and sperm together make one single cell, half of the cell having come from the mother,



half from the father. This cell then starts growing and developing.

As you developed from such a cell inside your mother's uterus, you grew larger, you changed, the inside parts of you, like heart and lungs and stomach and brain developed; the outside parts of

MY BODY AND HOW IT WORKS

you, like arms and legs and eyes and nose, developed also. You grew and developed until you looked like a real baby and were ready to come out.

Now, all the time this was happening you needed food to help you grow. You did not, however, get your food through your mouth. No, it came to you from your mother through a cord that was fastened onto you at the middle of your abdomen where your navel now is.

When you were ready to be born, out you came. And the very first thing you did was to cry in order to pump air into your lungs.

There you were, a naked, red, crying little baby. You had to be washed and dressed. You needed a great deal of sleep and a great deal of rest. You couldn't do much else but lie there and wink and blink and yawn and kick and wave your arms and drink. You drank milk first from your mother's breasts, and later from bottles. You grew.

After a while you were able to roll over. Then a little later you were able to sit up. Still later you were able to creep and then to stand and then to walk. Instead of crying "Waah" and blowing

BEFORE YOU WERE AS BIG AS YOU ARE NOW

bubbles and gurgling “Blub goo,” you began to make sounds like “ab a da ga” and later to make sounds like “ma ma ma,” and to begin saying words and really talking.

You grew in many ways. You learned many different things. For you went through a great many changes in becoming as big as you are now.

XIII. When You Grow Bigger

As you grow into a baby you go through many changes. As you grow from a baby to a child you go through still other changes, and as you grow from a child to a grown-up, still other changes take place.

“I know,” said Jerry. “I’ll have a beard on my face and I’ll need to shave every day.”

The growth of hair on boys’ faces is one sign of growing up. The growth of hair around the penis and under the arms comes before that on the face, and is also a sign of growing up. In the same way, girls have hair grow at the vulva and under their arms.

“But,” said John, “not on their faces.”

“And I know something else that is a signal of boys growing up,” put in Jean; “their voices change. First they get sort of high and squeaky and cracky. And then after a while they get man-nish and way down deeper than before.”

“Girls don’t get voices,” John remarked; “but they do get breasts.”

Girls change more altogether in bodily form

WHEN YOU GROW BIGGER

than do boys. Their breasts grow and their hips widen. At the same time that these outside changes are going on, inside changes are also occurring. For one, the ovaries and the uterus are growing. The ovaries commence sending ova out to the uterus every so often.

"As if the ovaries were practicing for the time when babies will be wanted later on," commented Jean.

Perhaps that is the case. No one exactly knows. But the fact remains that when a girl starts to grow up, from the age of eleven or twelve or thirteen or fourteen on, every month for several days she will notice that there is a flow of blood from the vagina. This is called menstruation.

Sometimes girls do not understand that this is a sign of growing up. They think they have hurt themselves, and when they see blood they imagine that they are bleeding from some cut or other. They do not realize that the blood is flowing from the uterus and has probably something to do with carrying out the ovum that has recently been sent there and is not needed just then to develop into a baby.

When, later on, an ovum is developing into a baby, then during the nine months in which the baby is growing, no menstruation takes place, but at other periods, up to around the age of forty-five or so, every month menstruation does occur.

Boys do not menstruate, nor do they have any other regular month by month sign of growing up. But at the age of twelve or thirteen they do have a sign which occurs occasionally, and which shows that the sperm in the testicles are developing and can be discharged through the penis. Sometimes at night a discharge of this kind takes place. A boy may wake up and find that there is a wet spot on his bed. He may at first think he has urinated, but will find that the fluid is much stickier and thicker. It is not urine, but semen, the fluid in which the sperm swim. Such discharges, which happen occasionally during sleep, are called seminal ejaculations. Boys sometimes call them "wet dreams." They are healthy signs that the boy having them is growing up.

And so as boys and girls grow, many different changes occur in their bodies inside and out. And not least, growing taller and broader and stronger comes along with the rest.

XIV. Mysterious Fluids

On the day when Jean and Jerry and John had been at the circus they had gone into the side shows and had seen some peculiar-looking creatures.

“Wasn’t the fat lady the fattest thing you ever saw?” asked John, with wide eyes. “She was as fat as a hippopotamus.”

“And the tall man, wasn’t he gigantic? I had to look up higher to see his face than I did to see the giraffe’s!”

“And the funny little dwarfs. I felt sorry for them. It must be awful to be grown-up and still be so tiny.”

Jean and Jerry and John were all interested to know that the reason the fat lady and the giant and the dwarves had not grown up normally the way most people do, was because certain inside parts of them had not worked properly.

At different places in the body lie clumps of cells called endocrine glands. These glands are supposed to play a very important part in regulating our growth. They have no tubes or other pathways connecting with different parts of the body,

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yet, mysteriously, they pour out fluids or secretions, which affect every part. If they pour out wrong amounts—either too little or too much—all sorts of peculiar things happen. If they manufacture too much of their powerful fluid secretions, then we fail to grow and digest and work as we should. If they manufacture too little of their secretions, again we fail to grow and digest and work as we should. People whose glands do not secrete properly, therefore, are queer and peculiar often not only in looks, but also in the way they act. One little boy, for instance, whose glands did not work properly, had a droopy, tired look and sat around and sat around and never felt like playing or reading or doing anything.

“Where are these glands,” asked Jerry, “and what are they called?”

One of them looks like a little grape hanging underneath the brain. It is called the pituitary gland. Another, a larger, purplish one lies in front of the lower part of the windpipe in the neck, and is called the thyroid gland. Near it lie four tiny glands called the parathyroids. Probably the fat on the enormous lady in the circus was due to a

MYSTERIOUS FLUIDS

failure of either the thyroid or the pituitary to manufacture enough fluid. The tallness of the giant had, on the other hand, possibly been due to too much secretion of the pituitary gland while he was growing up.

Two other glands called the adrenals are perched at the top of the kidneys like small mushroom caps.

Somehow, the glands are supposed to help us gain qualities which show us to be either men or women. The ovaries and testicles, also glands, are most important in this way.

No one understands exactly how all the glands work, nor just what each accomplishes. Many facts concerning them are deep mysteries. No one understands, for instance, why another one of the glands called the thymus should grow in the chests of children, but should almost disappear by the time the children reach fourteen years of age. The guess, of course, is that the thymus has finished doing what it was supposed to do and so is no longer needed.

Whether we are, in general, lively or quiet, jumpy or still, excitable or calm, gloomy or giggly,

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is again supposed in some way to have something to do with the fluids manufactured by these queer little clusters of cells which are to be found in various parts of our bodies and are called endocrine glands.

XV. As You Go On Living

John was chanting in a sing-songy voice. He was making up the words as he went along:

“I know about eyes,
I know about ears,
I know about stomachs.

“I know about muscles,
I know about bones . . .

“And I know, too, and I know, too, and I know, too.
I know more than you,”

sang Jean in a higher voice.

But Jerry looked thoughtful.

“Goodness!” he said. “Isn’t there a lot to learn!”

A lot there is, much more than Jerry or Jean or John had heard. Many books have been written on the subject. There are men and women, doctors and other scientists, who have studied for years and years and still have much to learn. And then, too, there are facts about the body which have not yet been found out, which not even the

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wisest and most learned men know. No one in the whole wide world understands everything about it.

"It's mysterious the way things are," remarked Jerry. "You wouldn't think so many different parts could be packed together inside of you in such a small space and yet have room enough to work. You wouldn't think your blood had cells in it that could fight away germs. You wouldn't think that a baby could develop from two tiny cells coming together."

Most mysterious, perhaps, of all, is the fact that as we go about our living we have many sorts of feelings. Sometimes we feel like dancing and singing. At other times we feel that we could just sit down and cry.

Even tiny newborn babies seem to have feelings. If a baby finds itself slipping or losing support, it seems to feel afraid and begins to cry. If its arms or legs are held so that it can't move, it seems to feel angry and starts to yell.

We feel sad. We feel glad. We do not understand exactly why.

AS YOU GO ON LIVING

But we do know it is important to be able to *feel happy.*

When we feel sad and gloomy, then our bodies do not work so well.

There was a boy who was dreadfully upset one day because his dog had run away. That afternoon he was slow and clumsy playing baseball. His muscles just would not work properly for him. He kept thinking all the time of his dog and worrying about it.

Being anxious and worried or being afraid keeps us from being happy.

There was another little boy who was tremendously frightened by a noise that he noticed one night after he had gone to bed. It was a low, rumbley sort of noise. It made his bed tremble. He felt like getting up and running to his mother. He felt like crying out. But, no, he had just been hearing a lot from some older boys about how "bad it was to be a fraidy cat." He didn't want anyone to think he was a "fraidy cat." And so night after night he listened to that low, rumbley noise and shivered and shook. The noise would come every so often and stop and come again and

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stop. He couldn't sleep, because of being afraid. He became more and more tired. His body couldn't do its work properly, because of his being tired. It couldn't digest his food well. He grew thinner. Goodness knows what would have happened. Fortunately, his mother noticed that things were not right and she asked him a lot of questions, and finally found out what had been troubling him and making him afraid and unhappy.

"Why, you silly boy!" she said. "You shouldn't have been ashamed to tell me. Come and I'll show you that those noises are really nothing to be frightened at." And she took him to a new bridge nearby that had been finished on the very evening that he had first heard those noises. She showed him how the automobiles and trucks passing over the bridge made just such low rumbling sounds. Then he understood that these were the cause of his fear. They were what he heard at night. There was nothing more to feel afraid of. He slept again. And again his body did its work well.

It is true, of course, that if you are sick you

AS YOU GO ON LIVING

will probably feel cross and grumpy. You know how it is when you have a cold.

But at other times you can often get rid of the unhappy feelings that keep your body from working as well as it should, by talking things over with some one who can help you understand the causes for your being unhappy. At least, if you are afraid or ashamed or bothered about something, don't be like the boy who didn't want anyone to think he was a "fraidy cat" and so didn't try to talk the thing over.

"I know how talking things over helps," Jean announced. "Remember last time Jerry had a birthday and got all those presents? I felt cross and didn't know why. But I talked it over with mother and decided I was angry because *I* wasn't getting any presents. Then I could remember that my turn would come next month. And, all the angry, humpy, heavy feelings seemed to go, and I felt light and smooth inside again."

"Talking things over helps in lots of ways," put in John. "Remember the day we had a fight about who should feed the dog, and we were all moping around and feeling sore, and fussing over

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our own meals, and getting sort of headachy? And remember how we talked it over and straightened it out to take turns? Then we all felt happy again."



Many unhappy feelings are caused by not having enough to do, by not having enough work and play.

The happiest girl that John knew was one of the busiest. She would paint lovely pictures, she would make things out of clay, she would build with hammer and saw and wood, she would build also with blocks. She would run in the

AS YOU GO ON LIVING

wind, and turn somersaults on the grass. She liked to read books, and make up stories of her own. She often helped around the house, too, washing dishes, brushing shoes, sweeping. She was continually thinking of interesting things to do.

“Well,” said Jerry. “I guess feelings have a lot to do with bodies, all right. And bodies have a lot to do with feelings.”

So if you want to go on growing stronger and bigger and finer, you will want to remember to eat proper foods, to get rid of wastes, to sleep and rest enough, to exercise enough, to have plenty of fresh air, and to keep finding ways of feeling happy.

THE END

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